Air Quality Impact Modeling Protocol – Construction Class I SIL and Visibility

Outer Continental Shelf Permit

Revolution Wind Farm

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August 12, 2022

VERSION 2

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Acronyms and Abbreviations

$\mu g/m^3$	microgram(s) per cubic-meter
BOEM	Bureau of Ocean Energy Management
CAA	Clean Air Act
CFR	Code of Federal Regulations
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COA	corresponding onshore area
COP	Construction and Operations Plan
CTV(s)	crew transport vessel(s)
EPA	United States Environmental Protection Agency
g/s	grams per second
GHG(s)	greenhouse gas(es)
IAC	inter-array cable
ICF	Interconnection Facility
km	kilometer(s)
KMVY	Martha's Vineyard Airport
MassDEP	Massachusetts Department of Environmental Protection

MERPs	Modeled Emission Rates for Precursors
MW	megawatts
NAAQS	National Ambient Air Quality Standards
NESHAP(s)	National Emission Standards for Hazardous Air Pollutant(s)
NSPS	New Source Performance Standards
nm	nautical miles
NNSR	Nonattainment New Source Review
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NSR	New Source Review
O_3	ozone
O&M	operations and maintenance
OBS	observed
OCS	outer continental shelf
OCSLA	Outer Continental Shelf Lands Act
OnSS	onshore substation
OSS(s)	offshore substation(s)
OTR	ozone transport region
Pb	lead
PM	particulate matter
$PM_{2.5}$	particulate matter smaller than 2.5 micrometers
PM_{10}	particulate matter smaller than 10 micrometers
PSD	Prevention of Significant Deterioration
PTE	potential to emit
RWEC	Revolution Wind Export Cable
RWF	Revolution Wind Farm
SER(s)	Significant Emission Rate(s)
SFWF	South Fork Wind Farm
SIL(s)	Significant Impact Level(s)
SO_2	sulfur dioxide
SOV(s)	service operating vessel(s)
tpy	tons per year
U.S.C	United States Code
USFS	United States Forest Service
VOC(s)	volatile organic compound(s)
VWF	Vineyard Wind Farm
WTG(s)	wind turbine generator(s)
WRF	Weather Research and Forecasting

1.0 PROJECT DESCRIPTION

Revolution Wind, LLC, a 50/50 joint venture between Orsted North America Inc. and Eversource Investment LLC, proposes to construct and operate the Revolution Wind Farm (RWF) and Revolution Wind Export Cable (RWEC) (herein referred to as the Project). The RWF will be located in federal waters on the outer continental shelf (OCS) in the designated Bureau of Ocean Energy Management (BOEM) Renewable Energy Lease Area OCS-A-0486, approximately 15 nautical miles (nm) southeast of Point Judith, Rhode Island, 13 nm east of Block Island, Rhode Island, approximately 7.5 nm south of Nomans Land Island National Wildlife Refuge (uninhabited island), Massachusetts, and between approximately 10 to 12.5 nm south/southwest of varying points of Rhode Island and Massachusetts coastlines. The lease area itself is approximately 98 square nm, 13 nm wide and 19 nm long at its furthest points. The RWEC will also be located in federal waters, originating from two proposed offshore substations (OSS) within the lease area, and eventually reaching Rhode Island state waters where the transmission cables will come on shore to be incorporated into the power grid at the proposed onshore substation (OnSS). Immediately neighboring the Project is South Fork Wind Farm (SFWF), which has been issued a final OCS Air Permit (OCS-R1-04), and is also being constructed and operated by the Orsted North America Inc. and Eversource Investment LLC joint venture. Approximately 10 nm away [19 kilometers (km)] is Vineyard Wind Farm (VWF), which has been issued a final OCS Air Permit.

The Project will utilize offshore wind energy as its renewable fuel to generate up to 880 megawatts (MW) of electric energy for sale. The Project will specifically include the following components:

Offshore:

- up to 100 Wind Turbine Generators (WTGs), each will have a capacity between 8 and 12 MW and connected by a network of Inter-Array Cables (IAC);
- up to two Offshore Substations (OSSs) connected by an OSS-Link Cable; and
- up to two submarine export cables (referred to as the Revolution Wind Export Cable [RWEC]), generally co-located within a single corridor.

Onshore:

- a landfall location located at Quonset Point in North Kingstown, Rhode Island (referred to as the Landfall Work Area);
- up to two underground transmission circuits (referred to as the Onshore Transmission Cable), co-located within a single corridor; and
- a new Onshore Substation (OnSS) located and Interconnection Facility (ICF) located adjacent to the existing Davisville Substation with interconnection circuits (overhead or underground) connecting the OnSS to the existing substation.

In March 2020, the Project submitted a Construction and Operations Plan (COP) to the Bureau of Ocean Energy Management (BOEM), and on April 30, 2021 BOEM published a Notice of Intent to prepare an Environmental Impact Statement. Revolution Wind assumes that all state and federal permits will be issued between Q1 and Q3 2023. Construction will begin as early as Q2 2023, beginning with the installation of the onshore components and initiation of seabed preparation activities (clearing of debris and obstructions). Concurrent construction durations (inclusive of commissioning) are summarized below:

Onshore:

- OnSS and ICF – approximately 18 months
- Onshore Transmission Cable – approximately 12 months
- RWEC Landfall – approximately 3 months

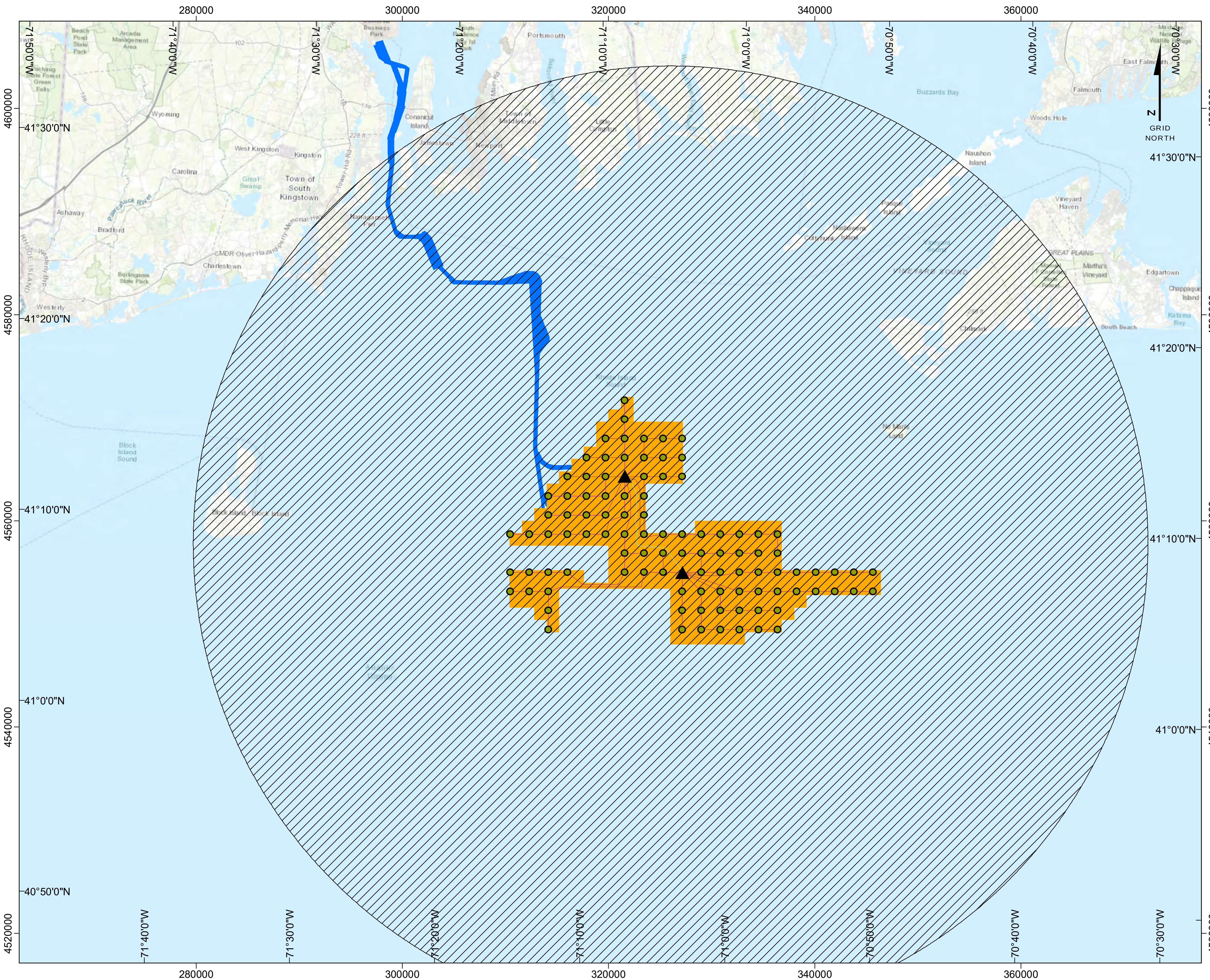
Offshore:

- RWEC – approximately 8 months
- WTG Foundations – approximately 5 months
- IAC – approximately 5 months
- WTGs – approximately 8 months
- OSSs (including foundations and OSS-Link Cable) – approximately 4 months

Figure 1-1 shows the Project lease area, the RWEC route, and the 25-nm radius area in which Project emission sources meeting the OCS source definition are considered OCS sources. A large majority of the Project's construction and operations and maintenance (O&M) emissions will be generated by the propulsion and auxiliary engines of vessels providing support within the lease area and while transiting to and from port(s). Revolution Wind is considering the use of several existing port facilities located in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Virginia, and Maryland to support offshore construction, assembly and fabrication, crew transfer and logistics.

To support the Project's approximate 12-to-18-month construction period and 20-to-35 years of O&M, aircraft, vessels, vehicles, and non-road fuel-burning equipment will be used, which will generate emissions of criteria and New Source Review (NSR) pollutants. To satisfy the requirements under 40 CFR § § 55, the Project is to obtain from EPA an OCS Air Permit for the Project emissions sources that meet the definition of an OCS source while within 25 nm [46 km] of the Project centroid. This construction air modeling protocol has been prepared in support of the OCS Air Permit Application for the Revolution Wind Project to fulfill the regulatory requirements codified in Part 55 of Title 40 of the Code of Federal Regulations (40 CFR § 55). A protocol for O&M-related emissions and modeling has been prepared separately. Details on construction activity durations and proposed modeling methodology can be found in the separate *Air Quality Impact Modeling Protocol – Operations and Maintenance Emissions*. OCS sources during decommissioning are not regulated by the OCS Air Permit application. A separate OCS Air Permit will likely be sought for decommissioning activities when the Project reaches the end of its life.

The protocol is organized in the following sections: Section 2 provides the air quality regulations and standards applicable to the Project's air quality impact analysis. Section 3 provides a detailed description of the proposed Project's components and emissions; Section 4 describes the proposed air quality modeling methodology for the Class I SILs analysis, Section 5 describes the proposed modeling methodology for the Class I Visibility evaluation, and Section 6 provides the supporting references cited herein. Appendix A includes figures with the receptors and source locations for the Class I area Significant Impact Analysis and Visibility Evaluation.



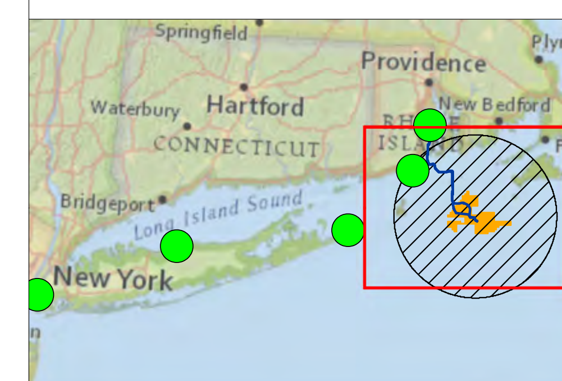
Construction Modeling Protocol

Figure 1-1

OCS Permit Area

Legend

- 25-nm OCS Permit Area
- RWF Lease Area
- RWEC Corridor
- OSSs
- WTGs
- OSS Link
- IAC
- Potential Ports



Reference system: NAD83 (2011)
Projection: UTM Zone 19N

0 2.5 5 7.5 10 Nautical Miles

0 5 10 15 20 Kilometers

Date: 02/02/2022
Document no:

Created by: K. MEARS
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2.0 APPLICABLE REGULATIONS AND STANDARDS

In accordance with Title III, Section 328 of the Clean Air Act (CAA), in which United States Environmental Protection Agency's (EPA) is required to establish OCS source requirements to attain and maintain Federal and State ambient air quality standards, 40 CFR § 55 establishes the regulatory air requirements for OCS sources located within 25 miles of states' seaward boundaries. Section 328 (a)(4)(c) of the CAA defines an OCS source to include any equipment activity, or facility that emits, or has the potential to emit, any air pollutant; is regulated or authorized under the OCS Lands Act; and is located on the OCS or in or on waters above the OCS. Furthermore, emissions from vessels servicing or associated with an OCS source shall be considered direct emissions from such a source while at the source, and while en route to or from the source when within 25 nm of the source.

OCS sources located within 25 nm of a state's seaward boundary are subject to the federal requirements set forth in 40 CFR § 55.13, and the federal, state, and local requirements of the corresponding onshore area (COA) set forth in 40 CFR § 55.14. Because the Project's lease area is located on the OCS within 25 nm of Massachusetts's seaward boundary, and the Massachusetts has been designated the COA, the Project is subject to the applicable requirements of the most current Massachusetts Air Regulations (310 CMR 6.00 - 8.00) that are incorporated into Appendix A of 40 CFR § 55. Notable federal, state, and local requirements of the COA that pertain to the air modeling protocol include New Source Performance Standards (NSPS); National Emission Standards for Hazardous Air Pollutants (NESHAPs); New Source Review (NSR) including Prevention of Significant Deterioration (PSD) review, and Nonattainment New Source Review (NNSR); and Massachusetts's Plan Approval Requirements.

2.1 Prevention of Significant Deterioration Review

The PSD program, as set forth in 40 CFR § 52.21 is incorporated by reference into 40 CFR § 55.13(d) of the OCS Air Regulations. PSD applies to OCS sources located within 25 nm of a state's seaward boundary if the PSD requirements are in effect in the COA. Per 40 CFR § 52, Subpart W, the PSD program is in effect in the Project's COA, Massachusetts.

The PSD program applies to new major sources of criteria pollutants or major modifications to existing sources in areas designated as being in attainment with or unclassifiable with the ambient air quality standards. Certain categories of stationary sources listed in 40 CFR 52.21(b)(1)(i)(a) are considered "major" if the source emits or has the potential to emit (PTE) 100 tons per year (tpy) or more of a "NSR regulated pollutant" as defined in 40 CFR § 52.21(b)(50). Per 40 CFR § 52.21(b)(1)(i)(b), all other stationary sources are considered "major" if it emits or has a PTE of 250 tpy or more of a regulated NSR pollutant. Revolution Wind does not fall under any of the stationary source categories listed under 40 CFR § 52.21; therefore, the Project's PSD applicability threshold for a NSR pollutant is 250 tpy.

Typically, when determining PSD applicability, emissions from mobile sources and construction are not included in the potential emissions. In the case of OCS sources, Section 328 of the CAA specifies that emissions from vessels servicing or associated with an OCS source shall be considered direct emissions from such a source while at the source, and while enroute to or from the source when within 25 nm of the source and shall be included in the potential to emit for an OCS source. Since this definition does not make an exception for emissions due to construction activity, when determining PSD applicability, the peak year of construction activity typically represents the highest annual emissions and determines whether the Project is subject to PSD review. In the case of Revolution Wind, the Project's potential emissions during construction exceed the 250 tpy PSD threshold and is consequently subject to PSD review.

Once a project is found to be subject to PSD review, the project emissions are then compared to Significant Emission Rates (SERs) to determine to which NSR pollutants the PSD review will apply. In addition, if estimated greenhouse gas (GHG) emissions, expressed as carbon dioxide equivalent (CO_2e), are greater than 75,000 tpy for a project that is a new major stationary source for at least one regulated NSR pollutant that is not GHGs, then GHGs are also included in the PSD review. Table 2-1 presents the Project's potential emissions compared to the PSD major source thresholds to determine to which pollutants the PSD review will apply. Any potential pollutant emissions estimated to be in excess of the SERs will need to be incorporated into the OCS Permit application to demonstrate that emissions from construction or operation of a source will not cause, or contribute to, air pollution in excess of any ambient air quality standards. In the case of this Air Quality Impact Modeling Protocol, the PSD review will apply to carbon monoxide, nitrogen oxides, volatile organic compounds, particulate matter, sulfur dioxide, and GHGs. Although SO_2 is below PSD applicability thresholds, because it is a precursor to $PM_{2.5}$, which is above the PSD threshold, SO_2 will be included in the secondary emissions calculations.

Table 2-1 Revolution Wind PSD Review Applicability

New Source Review Pollutant	Potential Annual Emissions (tpy)	SER (tpy)	PSD Review Applies?
Carbon Monoxide	1,155	100	**Yes**
Nitrogen Oxides	4,466	40	**Yes**
Volatile Organic Compounds	93	40	**Yes**
Particulate Matter (<10 micrometers)	153	15	**Yes**
Particulate Matter (<2.5 micrometers)	149	10	**Yes**
Sulfur Dioxide	17.0	40	No
Lead	0.02	0.6	No
GHGs (as CO_2e)	335,682	75,000	**Yes**

2.2 Ambient Air Quality Standards

EPA has established two sets of ambient air quality standards, each with their own purpose:

- National Ambient Air Quality Standards (NAAQS), which are the standards that protect public health a welfare and determine whether a given area is classified as an air quality attainment, nonattainment, or maintenance area, and
- PSD increments, which are the standards in place within attainment areas, in addition to the NAAQS, that prevent the air quality from deteriorating to the level set by the NAAQS.

The NAAQS, presented in Table 2-2, consist of primary and secondary standards of various exposure durations. Primary standards are intended to protect human health, whereas secondary standards are intended to protect public welfare from adverse effects from air pollutants, such as damage to property or vegetation. The NAAQS include the following six air contaminants, known as criteria pollutants:

- Carbon monoxide (CO),
- Nitrogen dioxide (NO_2),
- Particulate matter having an aerodynamic diameter of 10 micrometers or less (PM_{10}),
- Particulate matter having an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$),
- Sulfur dioxide (SO_2),
- Ozone (O_3), and
- Lead (Pb).

While the NAAQS are maximum allowable concentrations, PSD increments are the maximum allowable increase in concentration that is acceptable to occur above a baseline concentration for a pollutant. The baseline is defined for each pollutant and, in general, as the ambient concentration existing at the time that the first complete PSD permit application affecting the area is submitted, known as the minor source baseline date. EPA has established increment standards for NO_2, PM_{10}, $PM_{2.5}$, and SO_2 for various averaging periods Nomans Land Island in the Town of Chilmark in Dukes County, Massachusetts is the closest land area to the Project Lease Area. In Massachusetts, the PSD Increment, the maximum amount of pollution an area is allowed to increase, is tracked by county for $PM_{2.5}$ and by municipality for NO_2. No previous major source project has triggered the minor source baseline date, the date used to determine the baseline concentration in the area, in Dukes County, or any portion thereof. Because RWF will not be located within the jurisdiction of the Town of Chilmark or Dukes County, the Project does not establish a minor source baseline date for the onshore areas corresponding to the Project. Instead, as described in EPA's Outer Continental Shelf Preconstruction Air Permit Fact Sheet for SFWF, EPA will consider the RWF OCS Lease Area OCS-A 0486 as the baseline area for which the minor source baseline date is set upon receipt of the OCS Permit application (EPA, 2021a). Similarly, the minor source baseline area for SFWF is OCS Lease Area OCS-A-0517, and the minor source baseline date for this area is January 13, 2021. In the case of Revolution Wind, the NO_2, PM_{10} and $PM_{2.5}$ impacts will need to be evaluated within the Air Quality Impact Modeling for comparison against the respective PSD increments.

PSD increments vary in stringency based on the classification of the area. Class I increments are the most stringent and apply to designated Class I areas, such as areas of special national or regional scenic, recreational, or historic value. The nearest Class I areas to the Project are:

- Lye Brook Wilderness area which is 252 km [136 nm] from the Project at their nearest points, and
- Brigantine Wilderness area which is 310 km [167 nm] from the Project at their nearest points.

Class II areas comprise the remainder of the United States since there are currently no areas designated as Class III. So, all areas surrounding the Project except for those Class I areas listed above and overwater areas beyond federal waters are all subject to Class II PSD increments. The pollutants and corresponding NAAQS and PSD increment are provided in Table 2-2, along with each standards statistical form.

Table 2-2 Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS (ug/m^3)		PSD Increments (ug/m^3)	
		Primary	Secondary	Class I	Class II
CO	1-hour	40,000[1]	40,000[1]	-	-
	8-hour	10,000[1]	10,000[1]	-	-
NO_2	1-hour	188[2]	-	-	-
	Annual	100[3]	100[3]	2.5[8]	25[8]
$PM_{2.5}$	24-hour	35[4]	35[5]	2[1]	9[1]
	Annual	12[5]	15[5]	1[8]	4[8]
PM_{10}	24-hour	150[1]	150[1]	8[1]	30[1]
	Annual	-	-	4[1]	17[1]
SO_2	1-hour	196[6]	-	-	-
	3-hour	-	1,310[1]	25[1]	512[1]
	24-hour	-	-	5[1]	91[1]
	Annual	-	-	2[8]	20[8]
Ozone	8-hour	137.4[7]	137.4[7]	-	-
Lead	Rolling 3-month average	0.15[8]	0.15[8]	-	-

[1] Not to be exceeded more than once per year
[2] 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
[3] Annual mean
[4] 98th percentile, averaged over 3 years
[5] Annual mean, averaged over 3 years
[6] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
[7] Annual fourth-highest daily maximum ozone concentration, averaged over 3 years
[8] Not to be exceeded

Given the extent of modeling effort necessary to demonstrate compliance with these standards, EPA has historically used pollutant-specific concentrations, known as significant impact levels (SILs), to identify the degree of air quality impact that "causes, or contributes to" a violation of a NAAQS or PSD increment. Thus, the SILs are small fractions of the ambient air quality standards above and have been developed separately for NAAQS and PSD increment comparisons. In the case of PSD Increments, Class I and II and III areas each have unique SILs to protect the air quality to the degree necessary for each classification.

Prior to 2010, EPA had expressed support in guidance for applying the values in 40 CFR 51.165(b)(2) as SILs that could be used as part of a demonstration that a source does not cause or contribute to a violation of the NAAQS. However, in 2010 after EPA added Class I, II, and III SILs for $PM_{2.5}$ to 40 CFR 51.166(k)(2) and 52.21(k)(2), it was found that this addition contained rule text that did not provide enough flexibility for permitting authorities to require additional analyses in certain circumstances. As a result of this finding, these sections were vacated and repealed in 2013. However, the $PM_{2.5}$ NAAQS SIL value, that was also incorporated into 40 CFR 51.165(b)(2) as a result of the 2010 rulemaking, remained, since the accompanying rule text in this section did not have the same limitations, despite the NAAQS SIL values being the same as those for Class II areas in the vacated sections. Therefore, the only SILs that are currently codified are those in 40 CFR 51.165(b)(2), including 1-hour and 8-hour CO; annual NO_2; 24-hour and annual $PM_{2.5}$; 24-hour and annual PM_{10}; and 3-hour, 24-hour and annual SO_2. Although not codified, EPA also issued two memoranda in 2010 that included recommended 1-hour NO_2 and SO_2 SILs (EPA, 2010a, 2010b).

In 2018, rather than promulgating a new rule to address the flaw identified in 40 CFR 51.166(k)(2) and 52.21(k)(2), EPA issued a memorandum that provided recommended 8-hour ozone and 24-hour and annual $PM_{2.5}$ SILs to be applied on a case-by-case basis (EPA, 2018a). This approach was intended to provide permitting authorities the opportunity to use their discretion to apply and justify the application of the recommended SILs, while providing EPA with information and feedback to refine the SIL values and specific applications, as necessary, prior to any rulemaking. The memorandum acknowledged that $PM_{2.5}$ SILs still exist within 40 CFR 51.165(b)(2), which limits EPA from recommending NAAQS, Class II, or Class III SILs of a higher value than those currently codified. Therefore, even though EPA derived a SIL value of 1.5 ug/m^3 for 24-hour $PM_{2.5}$, EPA is bound by its previous 24-hour $PM_{2.5}$ SIL value of 1.2 ug/m^3. Conversely, EPA derived a SIL value of 0.2 ug/m^3 for annual $PM_{2.5}$, which is lower than its previous annual $PM_{2.5}$ SIL value of 0.3 ug/m^3. Therefore, the memorandum recommends instead using 0.2 ug/m^3 for the Class II and NAAQS annual $PM_{2.5}$ SIL. Table 2-3 below presents the SILs discussed above.

Table 2-3 Significant Impact Levels

Pollutant	Averaging Period	NAAQS SILs (ug/m^3)	PSD Increment SILs (ug/m^3)	
			Class I	Class II
CO	1-hour	2,000[1]	-	-
	8-hour	500[1]	-	-
NO_2	1-hour	7.5[2]	-	-
	Annual	1[1]	0.1[3]	1[3]
$PM_{2.5}$	24-hour	1.2[4]	0.27[4]	1.2[4]
	Annual	0.2[4]	0.05[4]	0.2[4]
PM_{10}	24-hour	5[1]	0.3[3]	5[3]
	Annual	1[1]	0.2[3]	1[3]
SO_2	1-hour	7.8[5]	-	-
	3-hour	25[1]	1[3]	25[3]
	24-hour	5[1]	0.2[3]	5[3]
	Annual	1[1]	0.1[3]	1[3]
Ozone	8-hour	1.96[4]	-	-

[1] 40 CFR § 51.165(b)(2)
[2] EPA's June 28, 2010, "*General Guidance for Implementing the 1-hour NO2 National Ambient Air Quality Standard in Prevention of Significant Deterioration Permits, Including an Interim 1-hour NO2 Significant Impact Level*" Memorandum
[3] 61 FR 38250, "*Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NSR)*"
[4] EPA's April 17, 2018, "*Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program*" Memorandum
[5] EPA's August 23, 2010, "*General Guidance for Implementing the 1-hour SO2 National Ambient Air Quality Standard in Prevention of Significant Deterioration Permits, Including an Interim 1-hour SO2 Significant Impact Level*" Memorandum

2.3 Source Impact Analysis for Construction Activities

Within 40 CFR 52.21(i) of the PSD program rule text are exemptions for certain requirements of the PSD program, provided that the source meets specific qualifications. Section 52.21(i)(3), sets forth an exemption from the requirements of 52.21:

(k) a source impact analysis,
(m) an air quality analysis, and
(o) additional impact analyses (impacts to visibility, soils and vegetation).

This exemption is contingent on the source meeting the conditions set forth within 40 CFR 52.21(3):

(i) that the source would impact no Class I area and no area where an applicable increment is known to be violated, and
(ii) the source would be temporary.

EPA typically considers sources operating for fewer than two years at a given location to be temporary for PSD permitting purposes (45 Fed. Reg. 52719, 52729; EPA Region 4, 2014). The Project's construction phase is expected to occur over approximately 12 to 18 months. Therefore, in accordance with pre-application discussions with EPA Region 1, emissions resulting from the Project construction are temporary and are not subject to requirements (k), (m), and (o) above, provided that condition (i) is also met.

The analysis required to determine whether the Project would impact a Class I area is described below and essentially follows the requirements of a source impact analysis set forth in 52.21(k), but only for Class I areas. Based on consultation with MassDEP and EPA there are no areas in the vicinity of the Project where an applicable PSD increment is known to be violated. For the purpose of modeling potential annual emissions, the 12-to-18-month OCS construction phase is conservatively assumed to occur over one year, so there is no peak year of emissions and the source is considered temporary. NSR pollutants that are expected to occur during the construction phase, as discussed in Section 2.1, and are subject to PSD review and modeling, are provided in Table 2-4 below.

Table 2-4 Construction Emissions

Applicable OCS Air Permit Construction Emissions (tpy)				
CO	NO_X	VOC	PM_{10}	$PM_{2.5}$
1,155	4,466	93	153	149

2.3.1 PSD Class I Areas Impact Analysis

Construction emissions will be modeled for comparison to the Class I PSD Increment Significant Impact Level (SIL) concentrations. In accordance with 52.21(k), in addition to the $PM_{2.5}$ construction emissions presented above, the potential for secondary emissions will also be considered for determining Class I impacts. As described in EPA's April 30, 2019 guidance memorandum, titled *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program*, $PM_{2.5}$ is comprised of two emissions categories: primary (i.e., emitted directly as $PM_{2.5}$ from sources) and secondary (i.e., $PM_{2.5}$ formed in the atmosphere by precursor emissions from sources) (EPA, 2019). Revised guidance for $PM_{2.5}$ Permit Modeling was provided in a September 20, 2021 document, titled *Revised DRAFT Guidance for Ozone and Fine Particulate Matter Permit Modeling* (EPA, 2021b). Both documents also provide guidance on determining ozone formation as secondary emissions; however, as discussed in Section 2.2 above, the Project is subject to NNSR and is not required to model ozone.

3.0 PROJECT CONSTRUCTION ACTIVITIES AND EMISSIONS

Air emissions associated with construction and O&M of the Project depend on many factors, such as location, scope, type, capacity of equipment, and schedule. Primary emission sources associated with RWF and RWEC will be from engine exhaust of marine vessel traffic, heavy equipment, and emergency generators. In general, most criteria pollutant emissions will be from internal combustion engines burning diesel fuel.

The potential emissions of air pollutants will occur during the following expected construction activities:

- Monopile installation,
- OSS topside installation,
- Turbine installation,
- Offshore export cable surveying, laying and burial activities,
- Offshore array cable surveying, laying and burial activities, and
- Transportation of materials, vessels, and staff to the site.

The modeling methodology contained in this protocol applies only to OCS source air emissions from construction activities. Details of the modeling method proposed for O&M emission are provided under separate cover. OCS permit emissions are defined pursuant to 40 CFR 55 as emissions from OCS sources, and vessels traveling to and from the contiguous OCS area.

3.1 OCS Sources

The emissions to be included in the modeling are those that will meet the definition of OCS source from 40 CFR 55.2 outlined below.

OCS sources means any equipment, activity or facilities which:

(1) Emits or has the potential to emit any air pollutant,
(2) Is regulated or authorized under the Outer Continental Shelf Lands Act ("OCSLA") (43 U.S.C Section 1331, et Seq.); and
(3) Is located on the OCS or in or on waters above the OCS.

The definition shall include vessels only when they are:

(1) Permanently or temporarily attached to the seabed and erected thereon and used for the purposes of exploring, developing or producing resources (therefrom, within the meaning of Section 4(a)(1) of OCSLA (43 U.S.C Section 1331, et. Seq.), and
(2) Physically attached to an OCS facility, in which case only the stationary source aspects of the vessels will be regulated.

Revolution Wind is having discussions with EPA to determine which vessels will meet this definition. In the following two subsections, Revolution Wind presents reasoning as to why various RWEC and WTG installation activities will not meet the definition of an OCS source. Per EPA's request, these activities will conservatively be included in the modeling to ensure that the modeling will support any outcome of these discussions.

3.1.1 Revolution Wind Export Cable Installation OCS Source Applicability

Per EPA's South Fork OCS Air Permit Fact Sheet, EPA no longer considers pull-ahead anchor cable laying vessels as meeting the definition of an OCS source (EPA, 2021a). Therefore, emissions from this vessel type are not applicable to the Project's PTE. However, to ensure that the modeling demonstrates compliance regardless of the outcome of ongoing discussions with EPA regarding non-OCS source modeling applicability, the cable-laying vessels will be included in the modeling.

3.1.2 Wind Turbine Generator Installation OCS Source Applicability

The WTGs will not have any pollutant-emitting equipment installed during the installation phase. During the commissioning phase, the WTGs will be powered by the integrated battery backup system and are not anticipated to require the use of a generator for installation or commissioning. However, in the unlikely scenario that there was not enough wind to charge the battery backup system ahead of the commissioning, temporary generators would be installed on the WTG for a few hours until the WTGs are connected to and are able to be powered by the grid. Considering that the WTGs will be located on the OCS where wind is rarely calm, this is considered an unlikely scenario.

However, under this scenario in which the battery backup system fails, the WTG would only meet the definition of "emits or has the potential to emit any air pollutant" for a few weeks until the temporary generator is removed. Therefore, the WTGs will not meet the definition of an OCS facility during the monopile installation activity or turbine installation activity. It is possible, although unlikely, that the WTG could meet the definition of an OCS facility during the commissioning phase if a temporary generator was needed due to insufficient wind. Therefore, Revolution Wind proposes that vessel activity associated with the WTGs will only meet the definition of an OCS source during the commissioning phase, and only the commissioning phase vessel activity will be modeled. WTG commissioning vessel activity is expected to consist of an SOV and CTV.

Revolution Wind understands that EPA is involved in discussions with other projects to determine the OCS classification of WTGs in the absence of installed generators. Therefore, to ensure that the modeling demonstrates compliance regardless of the outcome of ongoing discussions with EPA regarding non-OCS source modeling applicability, the WTG-related vessels will be included in the modeling. In the following sections, all vessel activity has been conservatively included in the air emissions source discussion and estimates.

3.2 Revolution Wind Farm

RWF construction activities will rely on combustion engines to transport crew, equipment, and materials, as well as complete installation of the WTGs and cable system. RWF construction vessels will transit between the RWF work area and onshore support and staging facilities at ports in Connecticut, Massachusetts, Rhode Island, New York, New Jersey, Maryland, and Virginia. Most of these vessels and equipment will use diesel engines burning low-sulfur fuel or gasoline, while some larger construction vessels may use bunker fuel.

RWF will use a monopile foundation type for the WTGs and OSSs. The monopile foundation consists of one steel monopile embedded into the sea floor. More details on the monopile foundations can be found in the COP from December 2021 (RWF, 2021). Project PTE emissions also include occasional use of a helicopter; however, this source does not meet the definition of an OCS source and contributes a negligible amount of emissions. The RWF will also use generators to assist with the installation and commissioning of RWF components. Some of the generators will be located on vessels, and some will be located on the OSSs.

3.2.1 Vessels

Most air emission from the Project will come from the combustion of fuels used to power main and auxiliary engines of various construction equipment and vessels for the RWF and RWEC. A summary of vessels that are expected to be used for the construction activities is provided in Table 3-1. Note that this table represents a best estimate of potential vessels for each construction activity. The vessels included in the final modeling may vary slightly during construction. The types of vessels expected to be used for the Project are listed and were classified as consistent with the equipment types used within the BOEM Emission Estimating Tool. Where available, vessel-specific engine data and Tier-specific emission factors were used for estimating emissions. The vessel emissions were calculated in the manner outlined below.

- An example of on-site (non-transit) long-term NO_X emissions from a heavy life installation vessel's auxiliary engine is below, which uses an IMO Tier 2 emission factor, vessel specific engine ratings (more conservative than BOEM defaults) and a BOEM default load factor.

$$0.920 \frac{g}{kWhr} x\ 1100\ kW\ x\ 1.0\ x\ \frac{3600\ hours}{year}\ x\ \frac{1\ lb}{453.6\ g}\ x \frac{1\ ton}{2000\ lb} = 40.2\ tpy$$

- For dynamic positioning vessels (all except CTVs, safety vessels and jack-ups), the main/propulsion engines are also calculated for on-site emissions and combined with the auxiliary engine emissions when determining on-site emissions. Below is an example of the short-term NO_X emissions from the heavy lift installation vessel's main/propulsion engines, which uses an IMO Tier 2 emission factor, vessel-specific engine ratings (more conservative than BOEM defaults) and a BOEM default load factor.

$$0.960 \frac{g}{kWhr} x\ 34560\ kW\ x\ 1.0\ x\ \frac{3600\ hours}{year}\ x\ \frac{1\ lb}{453.6\ g}\ x \frac{1\ ton}{2000\ lb} = 263.3\ tpy$$

3.2.2 Generators

Generators are expected to be used during the Project's installation and commissioning phase. It is anticipated that one 597 kW generator will be located on each OSS following installation and throughout the life of the project. An additional two 156 kW generators are anticipated to be temporarily located on the OSSs during commissioning. Additional small temporary generators will be used for the cable pull-in process during array cable installation. The construction phase generators are presented in Table 3-2. An example calculation of the long-term NO_X emissions calculations from one of the two 597 kW auxiliary engines is below. The calculation uses BOEM default emission factors.

$$5.97 \frac{g}{kWhr} x\ 597\ kW\ \ x\ \frac{2400\ hours}{year}\ x\ \frac{1\ lb}{453.6\ g}\ x \frac{1\ ton}{2000\ lb} = 18.9\ tpy$$

In addition to the generators discussed above, some of the vessels will have auxiliary generators and equipment to power equipment. These generators are calculated in the same way as described above and contribute 96.9 tpy of NO_X. The auxiliary generators and equipment are presented in Table 3-3.

Table 3-1 Revolution Wind OCS Construction Vessels

Vessel Type	Positioning Type	Monopile Installation	OSS Topside Installation	Turbine Installation	Export Cable	Array Cable
Heavy Lift Installation Vessel	DP	X				
Towing Tug (for fuel barge)	DP	X		X		
Anchor Handling Tug	DP	X				
Rock Dumping Vessel	DP	X				
Vessel for Bubble Curtain	DP	X				
Heavy Transport Vessel	DP	X	X			
Crew Transport Vessel	DP & Anchor(s)	X	X	X	X	X
PSO Noise Monitoring Vessel	DP	X				
Platform Supply Vessel	DP	X				
Jack-up Installation Vessel	Jack-up			X		
Pre-Lay Grapnel Run Vessel	DP				X	X
Boulder Clearance Vessel	DP				X	X
Sandwave Clearance Vessel	DP				X	X
Cable Lay and Burial Vessel	DP				X	X
Cable Burial Vessel - Remedial	DP				X	X
Tug - Small Capacity	DP				X	
Tug - Large Capacity	DP				X	
Guard Vessel/Scout Vessel	DP				X	
Survey Vessel	DP				X	X
DP2 Construction Vessel	DP				X	X
Service Operations Vessel	DP	X	X	X	X	X
Safety Vessel	Anchor(s)	X	X	X	X	X
Lift Boat	Jack-up	X	X	X	X	X
Supply Vessel	DP	X	X	X	X	X

Table 3-2 Revolution Wind OCS Construction Generators

Construction Type	Generator Use	Generator Location	Generator Count	Generator Rating (kW)
OSS Installation	Auxiliary Generators	OSS	1 per OSS	597
OSS Installation & Commissioning	Temporary Generators	OSS	2 per OSS	156
Array Cable	Cable Pulling	WTG	1	37
Array Cable	Cable Pulling	OSS	2	75

Table 3-3 Revolution Wind OCS Construction Vessel Equipment and Generators

Construction Activity	Equipment Type	Equipment Location	Generator Count	Generator Rating (kW)
Monopile Installation	Generator	Heavy Lift Installation Vessel	5	4
	Power Pack	Heavy Lift Installation Vessel	1	746
	Generator	Vessel for Bubble Curtain	23	358
	Generator	Heavy Transport Vessel	5	4
Turbine Installation	Generator	Jack-up Installation Vessel	5	4
	Cherry Picker	Jack-up Installation Vessel	2	67
	Generator	Feeder Barge	2	30
Export Cable	Generator	Barge Lay	2	75
	Crane	Barge Lay	3	567
	Generator	Barge Lay	7	187
	Power Pack	Barge Lay	1	373
	Cherry Picker	Barge Lay	1	112
	Excavator	Barge Lay	1	567
	Generator	Support Barge	2	45
	Cherry Picker	Support Barge	1	567

3.3 Revolution Wind Export Cable

The RWEC will transfer the electricity from the OSSs to shore. The RWEC corridor will traverse both federal and Rhode Island state waters. RWEC construction will mainly involve the cable-laying vessel and support vessels. Prior to the installation of the RWEC, seabed preparation activities including sandwave leveling and boulder clearance will be required. The vessels associated with this activity may make a few trips to ports. As presented in Section 3.1.1, Revolution Wind does not anticipate any vessels associated with RWEC will meet the definition of an OCS Source and will not be subject to the OCS Air Permit. A summary of the expected vessels to be used is presented in Table 3-1. More information detailing the RWEC construction activity can be found in the COP (RWF, 2021).

4.0 CLASS I SILS ANALYSIS

Modeling will be conducted to assess annual NO_X, annual and 24-hour PM_{10}, and annual and 24-hour $PM_{2.5}$ concentrations in the Class I areas located within 300 km of Revolution Wind's nearest point. The only Class I area within this proximity is Lye Brook Wilderness located in Vermont. The results of the modeling analysis will be compared to the Significant Impact Levels (SILs) for each pollutant.

4.1 Model Selection

Appendix W does not provide a preferred model for performing long-range transport modeling. Therefore, following discussions with EPA, modeling will be conducted using the CALPUFF air dispersion model (Version 5.8.5). CALPUFF is well suited for situations involving complex flows including spatial changes in meteorological fields due to facts such as the presence of complex terrain or the influence of water bodies, urbanization, plume fumigation (coastal fumigation or inversion break-up conditions), light wind speed or calm wind impacts, or other factors for which a steady-state-straight-line modeling approach is not appropriate. CALPUFF can account for the cumulative impacts of multiple spatially distributed sources within a large region and properly account for transport time and potential for stagnation and recirculation.

CALPUFF is recommended for Class I area air quality impact assessments by the Federal Land Managers Workgroup (FLAG, 2010). CALPUFF is also recommended by the U.S. Environmental Protection Agency (EPA) as the preferred model for Best Retrofit Available Technology (BART) analyses (Federal Register, July 6, 2005).

4.2 Background Air Quality

Because the Class I area is in Vermont, the most appropriate background air monitoring location was determined to be the Rutland, Vermont station (VTDEC, 2022). The air quality data from the station is presented in Table 4-1. These concentrations are considered representative of the Lye Brook Wilderness Area, as the monitoring station is located in sparsely populated area.

To ensure that the use of SILs is sufficiently protective of air quality, the selected background air quality data has been compared to the SILs to determine whether the difference between the NAAQS and the monitored background concentrations is greater than the corresponding SIL. The results of this comparison are presented in Table 4-2. All SILs are safely below the "NAAQS-Background" value.

Table 4-1 Background Air Quality (ug/m^3)

Pollutant	Monitoring Location	Averaging Period	2018	2019	2020	Selected Background
NO_2	Rutland, Vermont	Annual	13.0	12.7	10.8	13.0
$PM_{2.5}$	Rutland, Vermont	24-hour	20.4	20.0	22.2	20.9
		Annual	7.51	7.53	7.56	7.5
PM_{10}	Rutland, Vermont	24-hour	24	34	29	34

Table 4-2 Use of SILs Justification (ug/m^3)

Pollutant	Averaging Period	NAAQS (ug/m^3)	Selected Background	NAAQS – Background Delta	Class I SILs	Delta Greater than SILs?
NO_2	Annual	100	13.0	87.0	0.1	Yes
$PM_{2.5}$	24-hour	35	20.9	14.1	0.27	Yes
	Annual	12	7.5	4.5	0.05	Yes
PM_{10}	24-hour	150	34	116	0.33	Yes

4.3 Source Emissions

4.3.1 Annual Emissions

Annual emissions modeling will include NO_2, PM_{10} and $PM_{2.5}$. Construction emissions are aggregated into a single year for modeling and to provide the Project with flexibility in the timing of the construction activities. Construction emissions for NO_2, PM_{10} and $PM_{2.5}$ are expected from various activities and sources as described in Section 3. The tons per year emission rates presented in Table 2-4 will be divided by 8,760 hours and converted into grams per second before being applied to the annual emissions modeling. The transiting emissions will be conservatively based on all vessel transits originating from Rhode Island, which represents the ports closest to Lye Brook Wilderness. This is a very conservative approach for handling unpredictable port usage. In reality, the vessels will travel to and from several ports.

4.3.2 Short-term Emissions

The short-term emissions will include 24-hour PM_{10} and $PM_{2.5}$, and assume that all of the different construction activities could occur in the same 24 hours. This is a very conservative approach, since construction will have phases that will limit how much activity will overlap. NO_2 does not have a short-term SIL; therefore, it will not be modeled for this averaging period.

4.4 Source Characterization

The following subsections present how the emissions sources will be merged by location for the short-term modeling and long-term modeling. Figures A-1 and A-2 in Appendix A present the short-term and long-term source locations to be used in the modeling.

4.4.1 RWF Construction Vessels, Vessel Equipment/Generators and WTG Cable-Pulling Vessel

The emissions from on-site RWF vessels (all non-export cable vessels in Table 3-1), the WTG cable pulling generator (Table 3-2) and vessel equipment (monopile and turbine installation equipment in Table 3-3) will be modeled in CALPUFF using a single merged point source. For long-term modeling, the point source will be located at the centroid (based on averaging each WTG and OSS coordinate). The centroid has been selected as a representative location of the merged point source for long-term modeling for the reasons outlined below.

- In the long-term, construction activities at each WTG and OSS are expected to require about the same time and effort; therefore, modeling this activity at the average of these locations is the best way to represent this large area of activity when using a merged point source.
- The merged point source makes this approach very conservative since it condenses what would otherwise be hundreds of point sources over 98 square nautical miles into one ultra-concentrated point source. Using the centroid instead of the nearest WTG to Lye Brook Wilderness only slightly reduces the large conservatisms being applied when using this method.

- Lastly, it is possible that the construction period would occur for longer than just one year, so, on top of the conservatisms already mentioned, this approach of condensing all the emissions into one merged point source located at the centroid also assumes the worst-case condition where all of the construction emissions occur in one year.

To represent the worst-case scenario in the short-term modeling, the short-term merged point source will be located at the WTG nearest to Lye Brook Wilderness.

Because the vessels will be the primary emissions sources, the point source will be represented by vessel stack parameters. The vessels that will be used in the construction of RWF will vary considerably in stack height. One would assume the conservative approach would be to model the stack at the lower height, but there is considerable difference in elevation between the Project and Lye Brook Wilderness. To account for this, the vessel emissions point source will be modeled in two ways: 1) low stack height, and 2) high stack height. The scenario that results in the highest impact to the Class I receptors will be carried forward.

Table 4-3 presents the point source parameters that will be used for modeling the on-site RWF emissions.

Table 4-3 RWF Construction Vessels and Vessel Equipment/Generators Stack Parameters

Source Type	Stack Height (m)	Stack Temp. (K)	Stack Diameter (m)	Stack Velocity (m/s)
On-site RWF Vessels/Equipment/Generators (Tall Stack)	30	555	1.0	5
On-site RWF Vessels/Equipment/Generators (Short Stack)	5	555	1.0	5

4.4.2 RWEC Construction Vessels and Vessel Equipment/Generators and Transiting Vessels

The RWEC construction vessels (all export cable vessels in Table 3-1), vessel auxiliary equipment/generators (all export cable equipment in Table 3-3) and all vessel transits will be modeled along the RWEC route. In both the short-term and long-term, all of the vessels and equipment will be conservatively represented by 38 point sources located every 1 km along the RWEC route.

Like the RWF vessels, the RWEC installation-related vessels and transiting vessels will be the primary emissions source; therefore, these emissions will be modeled in a short and tall stack scenario. Table 4-4 presents the point source parameters that will be used for modeling the RWEC and transiting vessels/equipment and is identical to those in Table 4-3.

Table 4-4 RWEC Construction Vessels, Vessel Equipment/Generators, and Transiting Vessel Stack Parameters

Source Type	Stack Height (m)	Stack Temp. (K)	Stack Diameter (m)	Stack Velocity (m/s)
On-site RWEC Vessels and Equipment/Transiting Vessels (Tall Stack)	30	555	1.0	5
On-site RWEC Vessels and Equipment/Transiting Vessels (Short Stack)	5	555	1.0	5

4.4.3 OSS Generators

The OSS generators (OSS cable pulling, auxiliary and temporary generators in Table 3-2) will be modeled at each OSS and will be represented as being atop the OSS platform and assigned approximate values for flow parameters. Table 4-5 presents the point source parameters that will be used for modeling the OSS generators.

Table 4-5 OSS Generators Stack Parameters

Source Type	Stack Height (m)	Stack Temp. (K)	Stack Diameter (m)	Stack Velocity (m/s)
OSS Generators (2)	60	758	0.33	39.38

4.4.4 Source Emissions

The 24-hour modeling will use short-term emissions rates that don't account for the hours of operation per year of each vessel or equipment. The short-term modeling will further assume that all construction phase vessel and equipment activity will occur within the same 24 hours. This approach is extremely conservative, as it does not account for the construction schedule which will limit how much activity occurs at once, and it does not account for vessels that will be in limited supply and therefore, will not be numerous enough for multiple construction activities at once. Some vessels that will be performing several activities on site will possibly be performed by only one vessel, rather than multiples of the same vessel type. The modeling is even more conservative by grouping all of this activity into only 41 point sources. The 24-hour modeling emission rates are presented in Table 4-6.

Table 4-6 Revolution Wind 24-hour Average Modeling Emission Rates by Location (g/s)

Location	Source Type	PM_{10}	$PM_{2.5}$
Nearest WTG	On-site RWF Vessels	9.55	9.26
	Generators	0.0011	0.0011
	Vessel Equipment	0.436	0.423
RWEC Route (total for 38 sources)	On-site RWEC Vessels	3.50	3.38
	Transiting Vessels	29.76	28.73
	Vessel Equipment	0.25	0.25
OSS (total for 2 OSSs)	Generators	0.030	0.030
	Total	**43.50**	**42.03**

The annual modeling will use tons per year emission rates that account for the hours of operation per year of each vessel or equipment. The annual modeling will further assume that all construction phase vessel and equipment activity will occur in the same year. This approach is conservative as it groups all of this activity into only 41 point sources, whereas the annual activity of the vessels will be spread across the Lease area. The annual modeling emission rates are presented in Table 4-7.

Table 4-7 Revolution Wind Annual Average Modeling Emission Rates by Location (tpy)

Location	Source Type	NO_X	PM_{10}	$PM_{2.5}$
Centroid	On-site RWF Vessels	3,092.77	105.37	102.23
	Generators	0.15	0.0027	0.0027
	Vessel Equipment	65.38	3.24	3.15
RWEC Route (total for 38 sources)	On-site RWEC Vessels	464.61	16.47	15.91
	Transiting Vessels	774.02	26.17	25.26
	Vessel Equipment	31.53	1.47	1.42
OSS (total for 2 OSSs)	Generators	36.96	0.68	0.68
	Total	**4,466**	**153.41**	**148.65**

4.5 Secondary Impacts

Air contaminants that can lead to secondary formation of $PM_{2.5}$ include SO_2 and NO_X. SO_2 emissions transform into $PM_{2.5}$ through oxidation within the atmosphere, ultimately creating particulate sulfate and ammonium sulfate/bisulfate. NO_X emissions transform into $PM_{2.5}$ through gas-phase reactions to form nitric acid followed by condensation onto atmospheric particles, ultimately creating particulate nitrate.

In EPA's most recent September 20, 2021 guidance, titled *Revised DRAFT Guidance for Ozone and Fine Particulate Matter Permit Modeling*, EPA established new guidance that would require including all contributing pollutants in a secondary impact analysis, even if they are below the SER (EPA, 2021b). Therefore, even though potential SO_2 emissions are below the 40 tpy SER, the SO_2 emissions will be considered for secondary $PM_{2.5}$ impacts. Revolution Wind is proposing the use of the Modeled Emissions Rates for Precursors (MERPs) Tier 1 approach, as provided in the April 30, 2019 EPA guidance (EPA, 2019). As described in the guidance document, to derive a MERP value for the purposes of a PSD compliance demonstration, the model predicted relationship between precursor emissions from hypothetical sources and their modeled downwind impacts can be combined with the appropriate SIL value using the following equation:

$$MERP = appropriate\ SIL\ value * \frac{Modeled\ emission\ rate\ from\ hypothetical\ source}{Modeled\ air\ quality\ impact\ from\ hypothetical\ source}$$

This guidance document describes the approach for determining project specific MERPs as a tool for relating precursor emissions and peak secondary pollutant impacts from hypothetical sources, as modeled by EPA using CAMx. EPA created a total of 105 hypothetical sources across nine climate zones within the contiguous United States. Identifying the source locations by climate zone helps to capture the sensitivity that some climates have to precursor emissions due to higher concentrations of reactive compounds (i.e., PM nitrate impacts would be more sensitive to NO_X in areas rich in ammonia). Each hypothetical source was modeled with two stack heights: 10 meters and 90 meters. The 10-meter stack scenario was modeled with an emission rate of 500 tpy and in some cases 1,000 tpy, while the 90-meter stack scenario was modeled with an emission rate of 500, 1,000, and 3,000 tpy.

The resulting impacts are maintained on the Support Center for Regulatory Atmospheric Modeling's website in two live spreadsheets (EPA, 2022). One spreadsheet presents the maximum hypothetical source impacts, at any distance, as MERPs using Class II SILs. These MERPs have been calculated for use with Class II areas and represent the highest impacts at any distance from the hypothetical source modeling. Considering the distance of 252 km between the Project and Lye Brook Wilderness, this approach will not be used with the CALPUFF modeling. The other spreadsheet presents hypothetical source impacts in concentrations at varying distances, rather than pre-calculated MERPs. Using this spreadsheet, the secondary $PM_{2.5}$ impacts are determined with the following equation:

$$Project\ Impact\ in\ \frac{\mu g}{m^3} = Emission\ rate\ (tpy)\ from\ project * \frac{Modeled\ air\ quality\ impact\ from\ hypothetical\ source}{Modeled\ emission\ rate\ (tpy)\ from\ hypothetical\ source}$$

The Project will determine the representative daily and annual secondary $PM_{2.5}$ impacts from Project NO_X and SO_2 using the above formula.

Therefore, to consider the significant distance between the Project and the nearest Class I area, the secondary $PM_{2.5}$ Project impacts will be determined using the refined Class I secondary impacts spreadsheet with modeled secondary impacts at varying distances, paired with Equation 2.

Using the data from this spreadsheet, the first conservative approach is to determine the secondary $PM_{2.5}$ impacts at a distance greater than or equal to 50 km [27 nm]. Within the Northeast Climate Zone, the maximum daily NO_X precursor impact meeting this criterion is 0.414 ug/m^3 with an emission rate of 3,000 tpy. The maximum daily SO_2 precursor impact meeting this criterion is 1.048 ug/m^3 with an emissions rate of 3,000 tpy. For annual impacts, the maximum NO_X precursor impact meeting this criterion is 0.0119 ug/m^3 with an emission rate of 3,000 tpy. The maximum SO_2 precursor impact meeting this criterion is 0.0308 ug/m^3 with an emission rate of 3,000 tpy. Using these values with the 4,466 and 17.0 tpy of Project NO_X and SO_2 emissions presented in Table 2-1, the secondary daily and annual $PM_{2.5}$ impacts are presented in Table 4-9 below.

Table 4-9 First-Level Secondary $PM_{2.5}$ Impacts

Precursor	Daily $PM_{2.5}$				Annual $PM_{2.5}$			
	CAMx Impact (ug/m^3)	CAMx Emission Rate (tpy)	Project Impact (ug/m^3)	Total Impact (ug/m^3)	CAMx Impact (ug/m^3)	CAMx Emission Rate (tpy)	Project Impact (ug/m^3)	Total Impact (ug/m^3)
NO_X	0.414	3,000	0.6163	0.6223	0.0119	3,000	0.01769	0.01786
SO_2	1.048	3,000	0.0059		0.0308	3,000	0.00017	

The estimated annual secondary $PM_{2.5}$ impact using this approach is less than the Class I annual SIL of 0.05 ug/m^3 and leaves about 64% of the SIL for direct $PM_{2.5}$ impacts. Therefore, using an annual secondary $PM_{2.5}$ contribution of 0.018 ug/m^3 may be sufficient if the direct Class I $PM_{2.5}$ impacts at are less than 0.032 ug/m^3. However, the estimated daily secondary $PM_{2.5}$ impact is greater than the daily Class I SIL of 0.27 ug/m^3. Therefore, further refinement of the Class I secondary $PM_{2.5}$ impacts is necessary.

The second refined approach is to determine the secondary $PM_{2.5}$ impacts at a distance similar to the distance the Project is from the nearest Class I area, 252 km [136 nm] away. Within the Northeast Climate Zone, the maximum daily NO_X precursor impact meeting this criterion is 0.0914 ug/m^3 with an emission rate of 3,000 tpy. The maximum daily SO_2 precursor impact meeting this criterion is 0.174 ug/m^3 with an emission rate of 3,000 tpy. For annual impacts, the maximum NO_X precursor impact meeting this criterion is 0.0024 ug/m^3 with an emissions rate of 3,000 tpy. The maximum SO_2 precursor impact meeting this criterion is 0.0057 with an emission rate of 3,000 tpy. Using these values with the 4,466 and 17.0 of Project NO_X and SO_2 emissions presented in Table 2-1, the secondary daily and annual $PM_{2.5}$ impacts are presented in Table 4-10 below.

Table 4-10 Second-Level Secondary $PM_{2.5}$ Impacts

Precursor	Daily $PM_{2.5}$				Annual $PM_{2.5}$			
	CAMx Impact (ug/m^3)	CAMx Emission Rate (tpy)	Project Impact (ug/m^3)	Total Impact (ug/m^3)	CAMx Impact (ug/m^3)	CAMx Emission Rate (tpy)	Project Impact (ug/m^3)	Total Impact (ug/m^3))
NO_X	0.0914	3,000	0.1361	0.1371	0.0024	3,000	0.00359	0.0036
SO_2	0.1738	3,000	0.0010		0.0057	3,000	0.00032	

This final refined approach for determining secondary $PM_{2.5}$ impacts leaves approximately 49% and 93% remaining for daily and annual direct $PM_{2.5}$ impacts, respectively. For daily $PM_{2.5}$ impacts, the direct $PM_{2.5}$ impacts will be combined with 0.1371 ug/m^3 to determine compliance with the daily Class I SIL. For annual $PM_{2.5}$ impacts, if the direct annual $PM_{2.5}$ impacts exceed the remaining 0.0321 ug/m^3 from the refined first-level approach, the direct $PM_{2.5}$ impact will instead be combined with the 0.0036 ug/m^3 secondary impact using the second-level approach.

4.6 CALPUFF Configuration

No chemical transformation of NOX will be performed in the modeling (MCHEM = 0), which will result in a conservative assessment of annual NO2 concentrations. NOX to NO2 conversion will be conservatively assumed to be 100%. Additionally, no deposition will be calculated which will result in further conservatism. For all other model options, CALPUFF will be configured using settings consistent with USEPA Long Rang Transport guidance. After performing the CALPUFF modeling as described below, CALPOST Version 6.221 will be used for performing the evaluation of time-averaged concentrations.

4.7 Meteorological Data

Three years (2018-2020) of Weather Research and Forecast Model (WRF) prognostic meteorological data was supplied by the EPA. The data was processed into CALPUFF-ready binary format using the Mesoscale Model Interface (MMIF) program.

The original WRF simulation was provided in Lambert Conformal projection with an origin of 40.574 N, 97.000 W and standard parallels of 33 N and 45 N. The datum used in the WRF simulation was NSW-84 and the horizontal grid resolution was 12 km. The MMIF output created a domain size of 576 12 km cells in the x direction and 876 12 km cells in the y direction, with a southwest corner lat/long of 38.417 and -76.038 These projections and the grid resolution were maintained by MMIF and further used in the CALPUFF simulations.

The WRF meteorological data fields are being evaluated to ensure that they reliably represent conditions within the modeling domain. Comparisons are made with observed meteorological data within the modeling domain. The comparisons show that the WRF simulations provide a representative set of meteorological parameters which are important for air dispersion modeling. A supplemental submittal will be provided that will present the results of the meteorological data evaluation.

4.8 Model Domain

A modeling domain of the same size as the MMIF output described in Section 4.7 will be used, which will more than encompass the project site and Lye Brook Wilderness. A 12 km grid resolution consistent with the WRF simulations will be used in the CALPUFF modeling.

4.9 Class I Receptors

The Class I modeling will use Class I area receptors obtained from the National Park (NPS) data stored at the following website: https://irma.mps.gov/DataStore/Reference/profile/2249830. The 103 receptors for Lye Brook are shown in Figure A-3 in Appendix A.

The receptor locations were provided by NPS in latitude and longitude. These locations were converted to Lambert Conformal coordinates for use in CALPUFF consistent with the original WRF projection. Receptor heights provided in the downloaded receptor file will be used in modeling.

5.0 CLASS I VISIBILITY EVALUATION

In response to Revolution Wind's February O&M and Construction Protocols submittal, a Class I Visibility Evaluation of construction emissions was requested by the United States Forest Service (USFS). The request specified that such an evaluation will require use of CALPUFF with three years of MMIF data. In response to this request, Revolution Wind has prepared within the revised construction protocol, this section specific to Class I Visibility modeling.

The purpose of Air Quality Related Values (AQRV) modeling is to ensure that the Class I area resources (i.e., visibility, flora, fauna, etc.) are not adversely affected by the projected emissions for Revolution Wind. The closest Class I areas are Lye Brook Wilderness located in Vermont.

AQRVs that are generally evaluated for the federal mandatory Class I areas include:

- Visibility-Visual Plume
- Visibility-Regional Haze
- Acid Deposition

Visibility can be affected by plume impairment or regional haze. Plume impairment results from a contrast of color difference between a plume and a viewed background such as the sky or terrain feature. Regional haze occurs at distance where the plume has become evenly dispersed in the atmosphere and is not definable. The primary causes of regional haze are sulfates and nitrates, which are formed from SO_2 and NO_X through chemical reactions in the atmosphere. Impacts at distances greater than 30 to 50 km are generally referred to as regional haze. As detailed above, the USFS requested that the AQRV address visibility/regional haze; therefore, this protocol will not address acid deposition.

5.1 Model Selection

As detailed above, the USFS specifically requested that the Class I Visibility Evaluation utilize CALPUFF. When performing visibility related modeling, CALPUFF is used along with CALPOST to compute extinction coefficients and related measures of visibility, reporting these for selected averaging times and locations. Pollutant emissions will be based on annualized expected worst-case 24-hour emissions.

5.2 Source Emissions

The emissions to be used in the modeling will be based on 24-hour emission rates. The modeled pollutants will include PM_{10} (PMC), $PM_{2.5}$ (PMF), NO_X, SO_2, and VOCs. CALPUFF will also be configured to evaluate SO_4, HNO_3 and NO_3 concentrations dye to chemical transformation. The modeling will very conservatively assume that all of the different construction activities could occur in the same 24 hours. This is a very conservative approach, since construction will have phases that will limit how much activity will overlap.

5.3 Source Characterization

The sources will be represented by the same stack parameters as are presented in Sections 4.4.1 through 4.4.3. Please refer to these sections for details regarding point source parameters. As in the Class I SILs modeling, the Class I Visibility modeling will consider a tall stack and short stack approach for representing vessel emissions to determine the worst-case impacts.

5.3.1 Source Emissions

The Class I Visibility modeling will use short-term emissions rates that don't account for the hours of operation per year of each vessel or equipment. The short-term modeling will further assume that all construction phase vessel and equipment activity will occur in the same 24 hours. This approach is extremely conservative, because it does not account for the construction schedule that will limit how much activity occurs at once, and it does not account for vessels that will be in limited supply and therefore, will not be numerous enough to perform activity for multiple construction activities at once. Some vessels that will be performing several activities on site will possibly be performed by only one vessel, rather than multiples of the same vessel type. The modeling is more conservative by grouping all of this activity into only 41 point sources. The 24-hour modeling emission rates are presented in Table 5-1.

Table 5-1 Revolution Wind Class I Visibility Modeling Emission Rates by Location (g/s)

Location	Source Type	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOCs
Nearest WTG	On-site RWF Vessels	287.16	9.55	9.26	1.03	5.46
	Generators	0.062	0.0011	0.0011	6.2E-05	8.3E-08
	Vessel Equipment	9.16	0.436	0.423	0.015	0.63
RWEC Route (total for 38 sources)	On-site RWEC Vessels	96.88	3.50	3.38	0.43	2.00
	Transiting Vessels	704.07	29.76	28.73	4.33	17.89
	Vessel Equipment	5.51	0.25	0.25	0.0076	0.39
OSS (total for 2 OSSs)	Generators	1.63	0.030	0.030	0.0016	0.019
	Total	**1,102.83**	**43.50**	**42.03**	**5.81**	**26.37**

5.4 Meteorological Data

As requested by the USFS, three years of MMIF data will be used to perform the Class I Visibility modeling. Three years (2018-2020) of Weather Research and Forecast Model (WRF) prognostic meteorological data was supplied by the EPA. The data was processed into CALPUFF-ready binary format using the Mesoscale Model Interface (MMIF) program.

The original WRF simulation was provided in Lambert Conformal projection with an origin of 40.574 N, 97.000 W and standard parallels of 33 N and 45 N. The datum used in the WRF simulation was NSW-84 and the horizontal grid resolution was 12 km. The MMIF output created a domain size of 576 12 km cells in the x direction and 876 12 km cells in the y direction, with a southwest corner lat/long of 38.417 and -76.038 These projections and the grid resolution were maintained by MMIF and further used in the CALPUFF simulations.

5.5 Model Domain

A modeling domain of the same size as the MMIF output described in Section 5.4 will be used, which will more than encompass the project site and Lye Brook Wilderness. A 12 km grid resolution consistent with the WRF simulations will be used in the CALPUFF modeling.

5.6 Class I Receptors

The Class I modeling will use Class I area receptors obtained from the National Park (NPS) data stored at the following website: https://irma.mps.gov/DataStore/Reference/profile/2249830. The 103 receptors for Lye Brook are shown in Figure A-3 in Appendix A.

The receptor locations were provided by NPS in latitude and longitude. These locations were converted to Lambert Conformal coordinates for use in CALPUFF consistent with the original WRF projection. Receptor heights provided in the downloaded receptor file will be used in modeling.

5.7 CALPUFF Configuration

CALPUFF will be run using the FLM-approved default parameters where available. These options generally follow EPA's Guideline on Air Quality Models and EPA's Interagency Work Group on Air Quality Modeling (IWAQM) Phase 2 guidance.

5.7.1 Ozone and Ammonia

Background ozone concentrations are used in CALPUFF. A conservative default value of 80 ppb will be used for the visibility modeling.

Ammonia is not simulated by CALPUFF, but rather a background value is specified. Ammonia is important because the level of particulate nitrate (NO_3) can depend on the amount of ammonia present. The partitioning of total nitrate between gaseous HNO_3 and particulate NO_3 depend on the amount of ammonia present among other parameters (e.g., SO_4, temperature, relative humidity).

In the CALPUFF simulation, one value of background is assumed across the region and each puff uses the full background value in its equilibrium calculation. The IWAQM Phase 2 report contains the following recommendations for background ammonia: "typical (within a factor of 2) background values of ammonia are: 10 ppb for grasslands, 0.5 ppb for forest, and 1 ppb for arid lands at 20 degrees centigrade." Since there are limited active (or recently active) CASTNET sites between the Project and Lye Brook Wilderness, the Class I Visibility modeling will use a 1 ppb concentration for ammonia.

5.7.2 Natural Conditions and Monthly Relative Humidity Factors

Natural background conditions must be established to determine a change in natural conditions related to a source's emissions. The EPA lists three types of natural background conditions in their guidance document: Annual Average, Best 20 percent Days, and Worst 20 percent Days. Based on the 2010 FLAG document, annual average natural visibility conditions will be used for this analysis.

The best available retrofit technology (BART) guidelines, issued by EPA in 2005, concludes that by using monthly average relative humidity adjustment factors (f(RH)), the likelihood that the highest modeled visibility impacts that were caused by short-term and geographically different meteorological phenomena would be minimized. The FLAG 2010 document agreed with this determination; therefore, the Class I Visibility modeling will be conducted using monthly average f(RH) values for large and small ammonium sulfate, large and small ammonium nitrate and sea salt. These monthly values will be acquired from Tables 7 through 9 of the FLAG 2010 document.

5.7.3 Light Extinction and Haze Impact Calculations

CALPOST Version 6.221 will be used to calculate light extinction. The IMPROVE formula will be used to calculate the change in light extinction (b_{ext}) due to increases in the particulate concentrations.

For Lye Brook Wilderness, the values for input to the IMPROVE formula for calculating the change in light extinction due to increases in the particulate concentrations for the parameters will use the appropriate Rayleigh scattering term from Table 6 of the FLAG 2010 document. The assessment of visibility impacts will employ CALPOST Method 8 (MVISBK=8), sub-mode 5. CALPUFF assumes that all of the background ammonia is available for the formation of ammonium nitrate from each puff. However, where these puffs overlap in the model, puffs are actually in competition for the available ammonia. If necessary, to prevent the overestimation of NO3 formation, the ammonia limiting method option in the POSTUTIL processor will be used.

The relative humidity in CALPOST will be capped at 95%, consistent with current FLM recommendations.

CALPOST calculates the change in light extinction for each 24-hour day. These results will be reviewed to determine the number of days where the change in light extinction is at or above 5 percent change and 10 percent change. The impacts will also be discussed in the context of current visibility conditions.

6.0 REFERENCES

EPA, 2010a. "Guidance Concerning the Implementation of the 1-hour NO2 NAAQS for the Prevention of Significant Deterioration Program". U.S. Environmental Protection Agency, Research Triangle Park, NC. June 2010.

EPA, 2010b. "Guidance Concerning the Implementation of the 1-hour SO2 NAAQS for the Prevention of Significant Deterioration Program". U.S. Environmental Protection Agency, Research Triangle Park, NC. August 2010.

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EPA, 2021a. "Fact Sheet Outer Continental Shelf Preconstruction Air Permit 130 MW Offshore Windfarm South Fork Wind, LLC". EPA Draft Permit Number OCS-R1-04, U.S. Environmental Protection Agency Region 1. June 2021.

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DOI, 2010. "Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report – Revised (2010)". U.S. Department of the Interior. October 2010.

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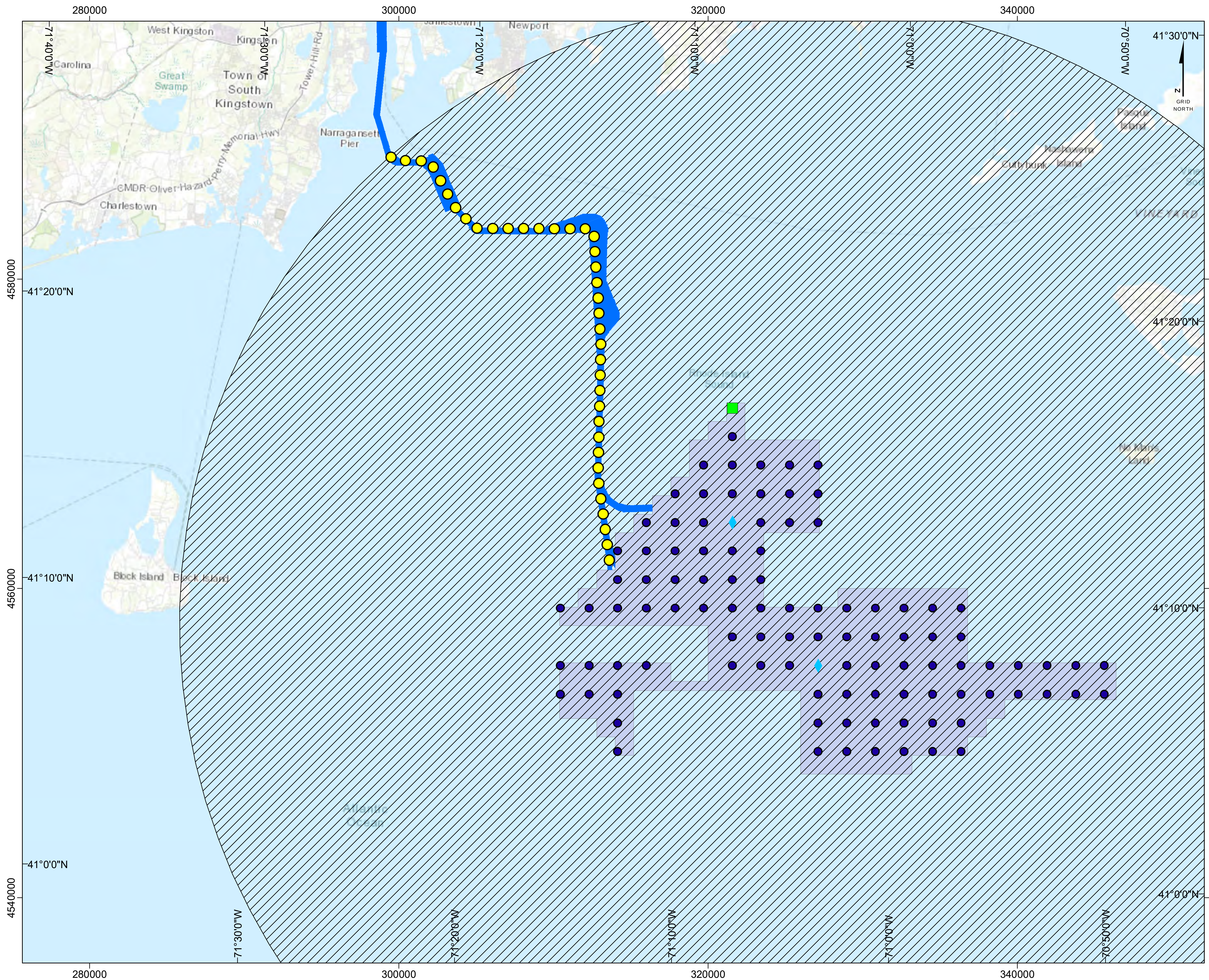
Vineyard Wind Farm (VWF), 2018. EPA-R01-OAR-2019-0355-0014. https://regulations.gov. Accessed April 2020.

Appendix A

CALPUFF Receptor and Point Source Locations

Revolution Wind
Figure A-1
Short-term Construction Source Locations



Legend

- Lease Area
- RWEC Corridor
- WTGs
- Area Subject to OCS Permit

Short-term Construction Sources

- Nearest WTG
- OSS
- RWEC and Transit Route

Anchorage, Environmental: Fugro
Shellgish Areas: MDMR
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster

0 250 500 1,000 Kilometers

0 125 250 500 Nautical Miles

Reference system: NAD83 (2011)
Projection: UTM Zone 19N

Date: 04/06/2021
Document no:

Created by: K. MEARS
Approved by: M. WALLACE

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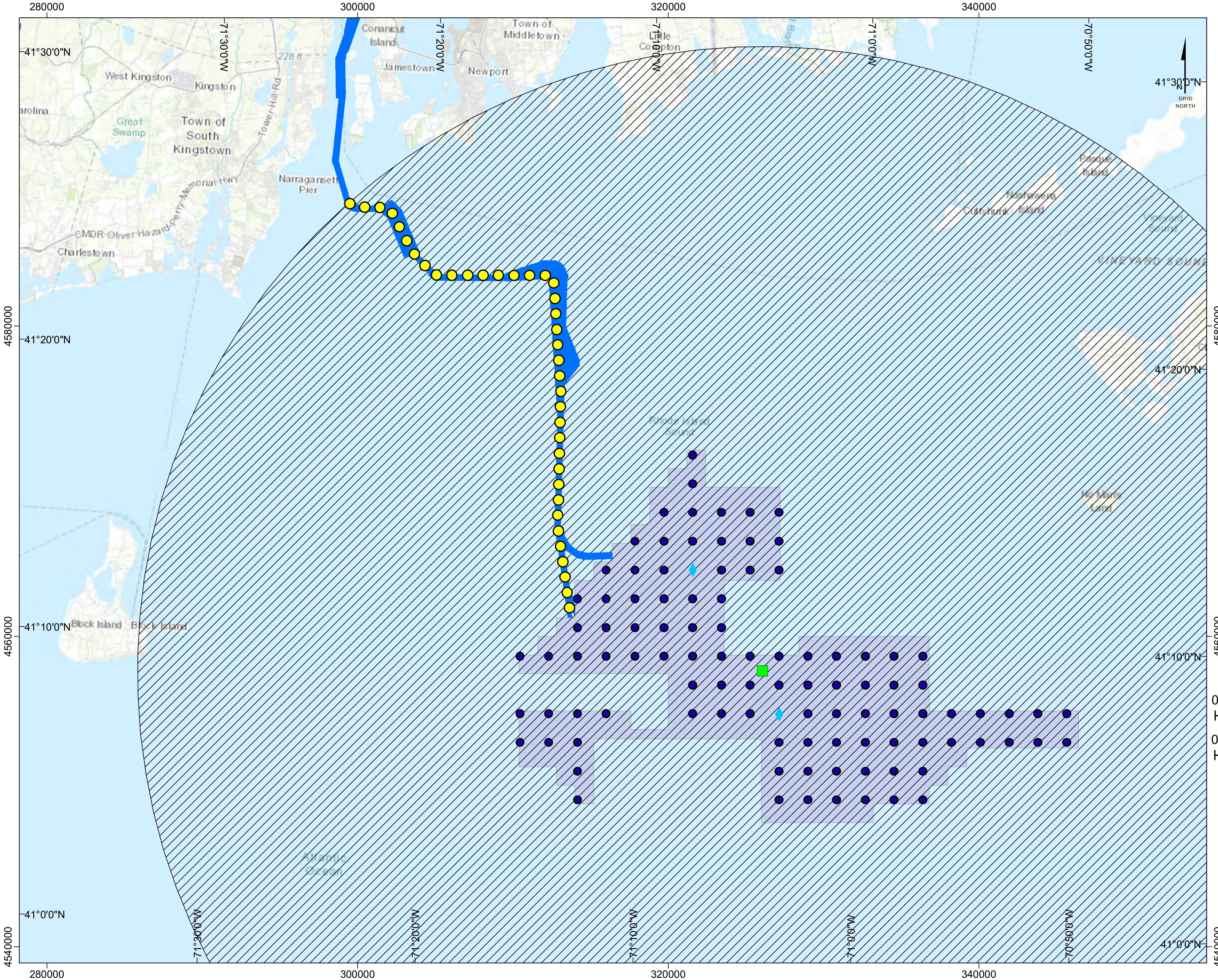
Revolution Wind

Figure A-2

Long-term Construction Source Locations



Legend

- Lease Area
- RWEC Corridor
- WTGs
- Area Subject to OCS Permit

Long-term Construction Point Sources

- Centroid
- OSS
- RWEC and Transit Route

Anchorage, Environmental: Fugro
Shellgish Areas: MDMR
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster

0 250 500 1,000 Kilometers

0 125 250 500 Nautical Miles

Reference system: NAD83 (2011)
Projection: UTM Zone 19N

Date: 04/06/2021
Document no:

Created by: K. MEARS
Approved by: M. WALLACE

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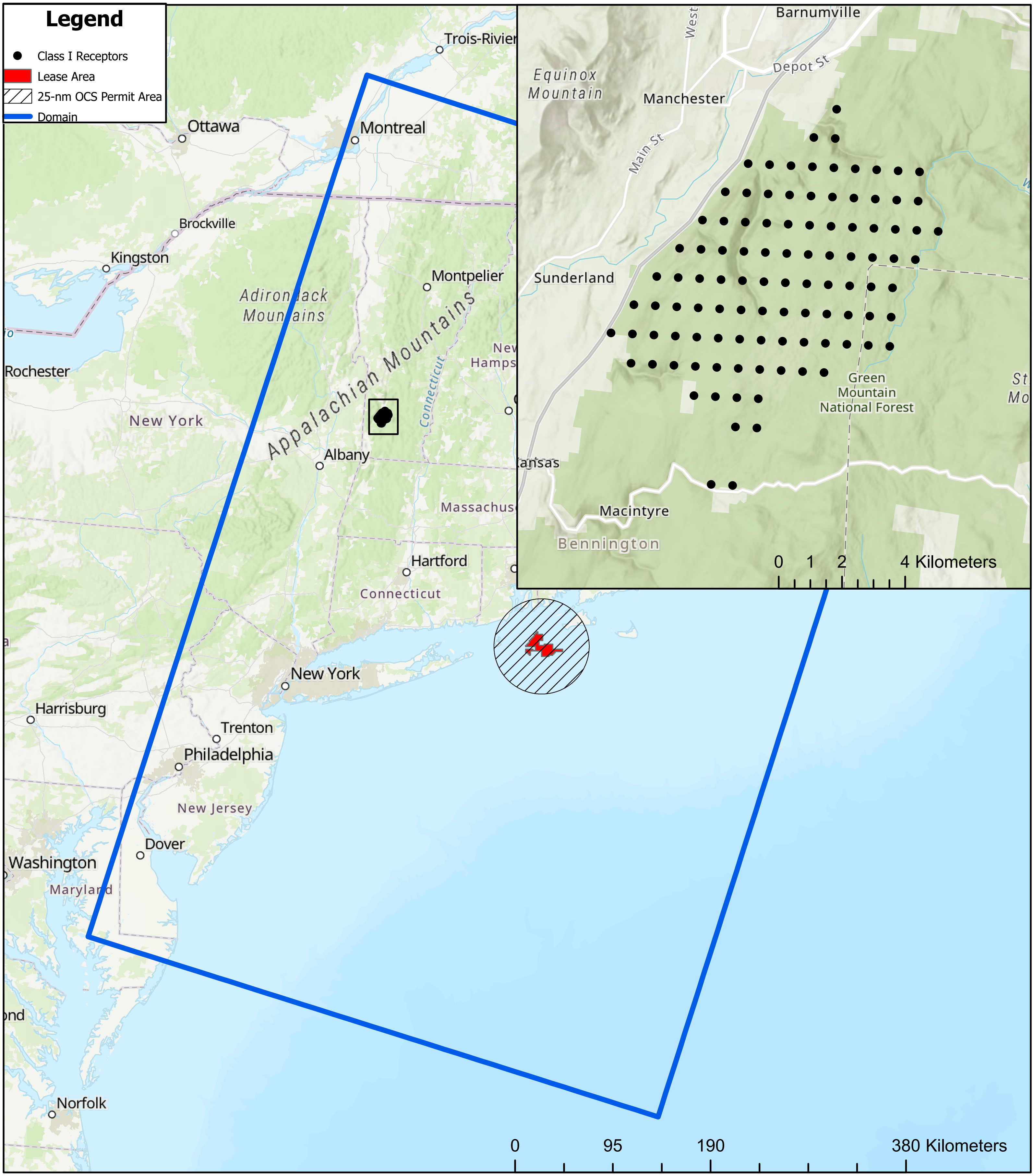

Figure A-3
Class I Receptors
Revolution Wind

TECH ENVIRONMENTAL
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Appendix B

EPA Comments and Revolution Wind Responses to Comments

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

April 21, 2022

Mark Roll, Permitting Manager
NA Permitting
Ørsted
56, Exchange Terrace, Suite 300
Providence, Rhode Island 02903

Dear Mr. Roll:

Thank you for the opportunity to review the draft Air Quality Impact Modeling Protocol – Construction and O&M Emissions for the Revolution Wind Farm Project. We have reviewed the protocol and provided comments based on our review. Comments are included as an enclosure to this letter. Please respond to our comments and resubmit the protocol before submitting Revolution Wind Farm Project Outer Continental Shelf air permit application.

Again, thank you for the opportunity to review the protocol. If you have any questions, please contact Chris Howard at (404) 562-9036 or howard.chris@epa.gov.

Sincerely,

Patrick Bird, Manager
Air Permits, Toxics, and Indoor Programs Branch

Enclosure

Cc: Katherine Mears, Tech Environmental
Whitney Marsh, Ørsted

ENCLOSURE

US EPA Comments on PSD Modeling Protocols for Revolution Wind
April 21, 2022

CONSTRUCTION EMISSIONS MODELING PROTOCOL

Section 2.3.1 – PSD Class I Areas Impact Analysis, Section 4.1 - Class I Dispersion Modeling and Section 4.1.3 – Receptors

1. These sections indicate that if impacts predicted by the OCD model at a distance of 50 km from the source exceed the Class I PSD Increment SIL for NO_2, the modeling will look at impacts out to 75 km [40 nm]. We acknowledge that impacts predicted by the OCD model at a distance of 75 km from the source are likely conservative considering the distance to the nearest Class I area (252 km). Nevertheless, modeling receptors at a distance of 75 km from the source is inconsistent with subsection 4.2 of 40 CFR Part 51, Appendix W – The Guideline on Air Quality Models. If it is necessary to assess impacts beyond 50 km from the source, the approach described in subsection 4.2(c)(ii) of Appendix W may be used.

Section 3.1.1 – Revolution Wind Export Cable Installation OCS Source Applicability

2. This section makes the following statement: "*Per EPA's South Fork OCS Air Permit Fact Sheet, EPA no longer considers pull-ahead anchor cable laying vessels as meeting the definition of an OCS source (EPA, 2021a). Therefore, emissions from this vessel type are not included in the RWEC modeling, but have been included in the Project's PTE*." While EPA has found that the operating characteristics of a pull-ahead anchor cable laying vessel is not an OCS source, emissions associated with pull-ahead anchor cable laying vessels should be modeled in a similar manner to other vessels servicing or associated with and OCS source within 25 miles of the wind development area. We request you include in the modeling of construction impacts pull-ahead cable laying vessel emissions that occuring within 25 miles of the wind development area (WDA) once the first OCS source is present on WDA.

Section 3.1.2 Wind Turbine Generator Installation OCS Source Applicability

3. EPA seeks to maintain consistency with its precedent to date of considering all offshore substations and wind turbine generators associated with a particular project as part of a single OCS facility. For this reason, we request that emissions from vessels servicing or associated with the OCS facility, including emissions from vessels servicing or associated with the Wind Turbine Generators (WTGs) and occuring within 25 miles of the OCS facility, to be included in a modeling analysis across the entire wind development area for the construction, commissioning, and operations phases of the project.

4. This section states that in the unlikely scenario that there was not enough wind to charge the battery backup system ahead of the commissioning, temporary generators would be installed on the WTG for a few hours until the WTGs are connected to and are able to be powered by the grid. The protocol should clarify how the emissions from the temporary generators will be addressed in the

modeling. Alternatively, if these sources will not be included in the modeling, justification should be provided for not including them.

Section 4.1 Class I Dispersion Modeling

5. There is a probable typographical error in Table 4-2. The Class I SILs listed in Table 4-2 for annual NO_2 and 24-hour PM_{10} should be .1 and .3 $\mu g/m^3$, respectively.

Section 4.1.3 Receptors

6. This section states that the OCD modeling will be performed using a full 360-degree arc of receptors placed at 50 km from RWF. The receptors will be separated by 1 degree resulting in an effective receptor spacing of approximately 870m. Based on Figure B-1, the receptor grid will include some land areas in the northern portion of the modeling domain. Terrain elevations for some of the receptors located on land will be substantially greater than the tops of the shortest RWF stacks that will be modeled. Therefore, to ensure that these higher terrain areas are captured in the modeling, EPA recommends that additional receptors be placed in the higher terrain areas with elevations that exceed the equivalent height of the shortest stack being modeled.

Section 4.1.5 Model Scenarios

7. This section indicates that for 24-hour modeling, three unique scenarios are expected to occur. These scenarios will be modeled separately since they can be reasonably expected not to occur within the same 24-hour period. Based on our experience with other wind energy developers, it is our understanding that some of these activities would occur concurrently at different portions of the WDA. Please provide additional support or information to verify these scenarios are no expected to occur within the same 24-hour period.

Section 4.3.2 Transiting Vessels

8. This section states that transiting vessels will be modeled as 12 point sources stretching over the 25 nm (~40km) area from the lease area to the edge of the OCS Permit area. This equates to approximately one point source every 3.3km. While EPA appreciates the need to not overburden the model with point sources, we recommend that Tech Environmental consider simulating the transiting vessels with additional point sources, e.g., perhaps one point source very 1-2 km.

Section 4.4 NO_X to NO_2 Conversion

9. This section indicates that because the OCD model does not contain an algorithm to account for the formation of NO_2 from NO_X, the NO_2 results may be adjusted using the EPA-provided ARM2 post-processor spreadsheet. The final modeling report should clearly document how the ARM2 mechanism was accounted for in post-processing.

Section 4.5 Secondary Impacts

10. EPA is unable to duplicate the daily and annual NO_x impacts shown in **Table 4-8** based on annual NO_x emissions of 2,725 tpy. We request clarification on how these values were determined.

11. Using the search criterion described in the paragraph above **Table 4-9** (maximum precursor impacts at distances greater than or equal to 50km for hypothetical sources in the northeast climate zone), we are unable to confirm the following values in Table 4-9:

   - The CAMx impact for daily NO_x impacts (.127 µg/m^3 @ 500 tpy) listed in the Table. Using the Qlik application, we are showing a value of .414 µg/m^3 @ 3,000 tpy.
   - The CAMx impact for annual NO_x impacts (.0071 µg/m^3 @ 1,000 tpy) listed in the Table. Using the Qlik application, we are showing a value of .0119 µg/m^3 @ 3,000 tpy.
   - The CAMx emission rate for annual SO_2 (1000 tpy). Using the Qlik Application, we are showing 3,000 tpy corresponding to an annual CAMx impact of .031 µg/m^3; and
   - The computed project impacts using the CAMx impacts and emission rates in the table.

   We request clarification on how these values were determined.

12. EPA is unable to confirm the following values in Table 4-10:

   - The CAMx impact for daily NOx impacts (.0487 µg/m^3 @ 1,000 tpy). Using the Qlik application, we are showing a value of .0914 µg/m^3 @ 3000 tpy.
   - The CAMx impact for annual NOx impacts (.00155 µg/m^3 @ 1,000 tpy). Using the Qlik application, we are showing a value of .0024 µg/m^3 @ 3000 tpy; and
   - None of the computed project impacts with the exception of the computed project impact for Annual SO_2.

   We request clarification on how these values were determined.

13. The paragraph above Table 4-11 on page 22 of the modeling protocol states that EPA's MERPs guidance suggests using the maximum primary $PM_{2.5}$ impact at a distance greater than, or equal to, the distance the Project is from the nearest Class I area, 252 km [136 nm] away. The following is an excerpt from page 52 of Section 4.1.2 of EPA's April 2019 MERPs Guidance:

   "*Another option for this screening step would also involve selecting the highest modeled secondary $PM_{2.5}$ impact at or near the downwind distance of the Class I area relative to the project source but include an estimate of primary $PM_{2.5}$ impacts estimated with a chemical transport model (e.g., Lagrangian or photochemical model) <u>at or less than the downwind distance of the Class I area relative to the project source</u>*."

   Since the distance from the Project to the nearest Class I area is 252km, EPA recommends that a maximum distance of 200 km be used in the application of Table 4-2 of the MERPs Guidance.

O&M EMISSIONS MODELING PROTOCOL

<u>Section 2.3.3.2 – NAAQS Cumulative Impact Analysis</u>

14. This section presents four reasons supporting non-inclusion of any on-land sources in NAAQS cumulative modeling. EPA's concurrence with exclusion from cumulative modeling of the sources

located on Martha's Vineyard (Item 3) will, to a great extent, depend on the extent of the significant impact areas of the relevant pollutants for Revolution Wind, as well as the annual emissions of the sources proposed for exclusion.

15. This section also presents a case for not including South Fork Wind in a cumulative impact analysis for NAAQS modeling for Revolution Wind. After reviewing the relationship between Revolution Wind and South Fork Wind, EPA has preliminarily determined these two projects are the same stationary source for Clean Air Act permitting purposes.

    EPA regulations define "stationary source" as "any building, structure, facility, or installation which emits or may emit a regulated NSR pollutant."[1] Those regulations, in turn, define the term "building, structure, facility, or installation" to mean "all of the pollutant-emitting activities which [1] belong to the same industrial grouping, [2] are located on one or more contiguous or adjacent properties, and [3] are under the control of the same person (or persons under common control)," with "same industrial grouping" referring to the same Major Group, two-digit SIC code.[2] EPA commonly refers to this three-part analysis as a "source determination" analysis.

    The need for a cumulative impact analysis, within the context of EPA's Prevention of Significant Deterioration permitting program, may apply to the new Revolution Wind project. That is, if modeled impacts from Revolution Wind are above the SIL for any pollutant, a cumulative impact analysis that takes into account the pollutant emissions for South Fork Wind (and any nearby sources, if determined appropriate) would be required to be analyzed together, along with background concentrations. The protocol should be revised to account for the potential need for a cumulative impact analysis based on EPA's preliminary determination that the Revolution Wind and South Fork Wind projects are the same stationary source for Clean Air Act permitting purposes.

<u>Section 2.3.4.1 – PSD Increment Cumulative Analysis Approach</u>

16. This section presents a case for not including South Fork Wind in cumulative 24-hour PM10 and PM25 increment modeling for Revolution Wind. Like our comment regarding NAAQS modeling, a cumulative impact analysis may be required for increment if Revolution Wind models above the SIL for any pollutant. See comment #15 for more details on EPA's rationale for requiring this.

17. In this section, a case is presented for excluding South Fork Wind from any cumulative 24-hour PM_{10} and $PM_{2.5}$ increment modeling. Modeling performed by South Fork Wind in support of their permit indicated that 97% of the 24-hour $PM_{2.5}$ increment would be consumed. However, Tech Environmental argues that South Fork's modeling was overly conservative. Even though the modeling indicating near total consumption of the $PM_{2.5}$ increment is likely conservative, the modeling does at least indicate a potential issue with the 24-hour $PM_{2.5}$ increment in the area and this potential issue should be addressed. Since short term increments may only be exceeded once per year, and the 14 days of emissions associated with Scenario 2 could theoretically occur in one year, EPA recommends that South Fork be included in any cumulative $PM_{2.5}$ increment modeling for Revolution. In the unlikely event that compliance with the increment cannot be demonstrated when

[1] 40 CFR § 52.21(b)(5); 40 CFR § 51.165(a)(1)(i); 40 CFR § 51.166(b)(5); *see* 42 U.S.C. § 7602(z) (defining "stationary source" as "any source of an air pollutant" except those emissions resulting directly from certain mobile sources or engines).
[2] 40 CFR § 52.21(b)(6); 40 CFR § 51.165(a)(1)(ii); 40 CFR § 51.166(b)(6). A "source" should also comport with the "common sense notion of a plant," and avoid the aggregation of pollutant-emitting activities that would not fit within the ordinary meaning of "building, structure, facility or installation (45 FR at 52694)."

modeling South Fork conservatively, then we further recommend that South Fork be modeled in a more realistic (less conservative) manner. An additional alternative would be to demonstrate that the 24-hour PM_{10} and $PM_{2.5}$ significant impact areas for the two facilities do not overlap.

Section 2.4 Class II AQRV Assessments and Section 3.10 – Visibility

18. Section 2.4 indicates that based on preliminary emissions and distance to the nearest Class I location, it is not expected that impacts from the Project will have an adverse effect on visibility in the Class I area. Section 3.10 states that the results of the Q/D assessment will be summarized in the form "Request for Applicability of Class I Area Modeling Analysis" and provided to the U.S. Forest Service (USFS) for their determination on whether a Class I Air Quality Related Values (AQRV) analysis is needed. The USFS has requested an AQRV analysis for visibility impacts at Lye Brook from construction-related emissions.

Section 2.6 – Summary of Modeling Requirements

19. Table 2-9 of this section indicates that a Class I SIL analysis is not necessary for O&M emissions. Per Table 2-1, PSD is triggered for NO_x, PM_{10} and $PM_{2.5}$. Since Class I increments are established for these pollutants, a Class I SIL analysis is required.

Section 3.4.1 – Operations and Maintenance Activities

20. This section of the protocol states that there are four scenarios that are expected to occur during the O&M phase of the Project. These scenarios include:

    1) routine daily inspections and maintenance,
    2) nonroutine repairs of WTGs and OSSs,
    3) routine infrequent array cable and foundation surveys, and
    4) routine infrequent export cable surveys.

    The protocol states that the use of survey vessels for Scenarios 3 and 4, will occur along the cable routes and will not meet the definition of an OCS source. Therefore, only Scenarios 1 and 2 will be included in the modeling. While EPA has found that the operating characteristics of a pull-ahead anchor cable laying vessel is not an OCS source, vessel emissions associated with servicing or associated with an OCS source/facility and occuring within 25 miles of the wind development area should be considered direct emissions of the source. We request you include in the modeling of impacts scenario 3 and 4 vessel emissions that occuring within 25 miles of WDA once the first OCS source is present on WDA.

Section 3.4.2 – Non-routine Wind Turbine Generator Substation Repair Activities (Scenario 2) and
Section 3.4.3 – Daily Inspections and Maintenance Activities (Scenario 1)

21. An example calculation should be provided for one of the vessels or pieces of equipment shown in Tables 3-4 and 3-6. These example calculations should be provided for each pollutant and averaging period and identify the key assumptions used in the calculation. We recommend that this calculation be shown for the vessel or equipment with the largest emissions for each Scenario.

Section 3.4.4 – Transiting Vessels

22. This section states that transiting vessels will be modeled as 12 point sources stretching over the 25 nm (~40km) area from the lease area to the edge of the OCS Permit area. This equates to approximately one point source every 3.3km. While we appreciate the need to not overburden the model with point sources, we recommend that Tech Environmental consider simulating the transiting vessels with additional point sources, e.g., perhaps one point source very 1-2 km.

Section 3.5 - Nitrogen Oxide Conversion

23. Because the OCD model does not contain an algorithm to account for the formation of NO_2 from NO_X, the NO_2 results may be adjusted using ARM2 post-processing. The final modeling report should clearly document how the ARM2 mechanism was applied in post-processing.

Section 3.6 – Source Configuration of O&M Scenarios

24. Clarification is requested regarding the locations that will be used for the sources included in the long-term modeling.

Section 3.9 - Comparison to EPA Guidance

25. This section of the protocol presents justification for use of intermittent treatment of O&M activities for modeling 1-hour NO_2. Using this approach, for each WTG or OSS location, the O&M vessels will be modeled based on the number of hours per year they will be emitting at that location, divided by 8,760. On page 25 of Section 3.9, it is stated that for each WTG or OSS location, the O&M vessels were modeled based on the number of hours per year they would be emitting at that location, divided by 8,760. We would like confirmation that this annualization of emissions and associated modeled emission rates in Tables 3-4 and 3-6 were calculated in this manner.

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MEMORANDUM

To: Patrick Bird, Manager, EPA Region 1 – Air Permits, Toxics, and Indoor Programs Branch
From: Whitney Marsh, Ørsted
CC: Marc Wallace & Katherine Mears, Tech Environmental
Date: July 1, 2022
Subject: Revolution Wind OCS Air Permit Application- Construction and O&M Air Dispersion Modeling Protocol Response to Comments

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Tech Environmental, Inc. (Tech) is responding to EPA's comment letters, dated April 21 and April 26, 2022. In response to your comments, Tech has revised Revolution Wind's Air Quality Impact Modeling Protocol – Operations & Maintenance Emissions and Appendix A to the Air Quality Impact Modeling Protocol – Construction Emissions. Tech has provided responses below to address each of your received comments.

Construction Emissions Modeling Protocol

1. *<u>Sections 2.3.1, 4.1 & 4.1.3.</u> These sections indicate that if impacts predicted by the OCD model at a distance of 50 km from the source exceed the Class I PSD Increment SIL for NO2, the modeling will look at impacts out to 75 km [40 nm]. We acknowledge that impacts predicted by the OCD model at a distance of 75 km from the source are likely conservative considering the distance to the nearest Class I area (252 km). Nevertheless, modeling receptors at a distance of 75 km from the source is inconsistent with subsection 4.2 of 40 CFR Part 51, Appendix W – The Guideline on Air Quality Models. If it is necessary to assess impacts beyond 50 km from the source, the approach described in subsection 4.2(c)(ii) of Appendix W may be used.*

   Tech will perform the construction modeling via CALPUFF, rather than first modeling with OCD.

2. *<u>Section 3.1.1.</u> This section makes the following statement: "Per EPA's South Fork OCS Air Permit Fact Sheet, EPA no longer considers pull-ahead anchor cable laying vessels as meeting the definition of an OCS source (EPA, 2021a). Therefore, emissions from this vessel type are not included in the RWEC modeling, but have been included in the Project's PTE." While EPA has found that the operating characteristics of a pull-ahead anchor cable laying vessel is not an OCS source, emissions associated with pull-ahead anchor cable laying vessels should be modeled in a similar manner to other vessels servicing or associated with and OCS source within 25 miles of the wind development area. We request you include in the modeling of construction impacts pull-ahead cable laying vessel emissions that occurring within 25 miles of the wind development area (WDA) once the first OCS source is present on WDA.*

   Tech will include the cable-laying vessel emission within the construction modeling using CALPUFF.

3. <u>Section 3.1.2.</u> *EPA seeks to maintain consistency with its precedent to date of considering all offshore substations and wind turbine generators associated with a particular project as part of a single OCS facility. For this reason, we request that emissions from vessels servicing or associated with the OCS facility, including emissions from vessels servicing or associated with the Wind Turbine Generators (WTGs) and occurring within 25 miles of the OCS facility, to be included in a modeling analysis across the entire wind development area for the construction, commissioning, and operations phases of the project*

   The protocol includes emissions from vessels servicing or associated with the OCS facility, including emissions from vessels servicing or associated with the Wind Turbine Generators (WTGs) and occurring within 25 miles of the OCS facility, to be included in a modeling analysis across the entire wind development area for the construction, commissioning, and operations phases of the project. The protocol has been revised to make more evident.

4. <u>Section 3.1.2.</u> *This section states that in the unlikely scenario that there was not enough wind to charge the battery backup system ahead of the commissioning, temporary generators would be installed on the WTG for a few hours until the WTGs are connected to and are able to be powered by the grid. The protocol should clarify how the emissions from the temporary generators will be addressed in the modeling. Alternatively, if these sources will not be included in the modeling, justification should be provided for not including them*

   Most recent information from Revolution Wind is that if a WTG's battery backup system was not functioning during commissioning, a temporary generator would be installed on the WTG. Any such temporary generators would be 37 kW and would run for one hour per day every 3 days, for a total of 7 hours. Even if the battery backup systems were not functioning on all of the up to 100 WTGs, the total potential to emit for all of the temporary generators are de minimis. Using a 7.5 g/kW-hr emission factor, it was found that this exceedingly unlikely worst-case scenario would contribute only 0.21 tons of NO_X. Therefore, because the emissions of the exceedingly unlikely worst-case scenario results in de minimis emissions, that would be further hard to predict when they may occur, these emissions are being excluded from the modeling.

5. <u>Section 4.1.</u> *There is a probable typographical error in Table 4-2. The Class I SILs listed in Table 4-2 for annual NO2 and 24-hour PM10 should be .1 and .3 µg/m3, respectively.*

   The annual NO_2 SIL has been changed to 0.1 µg/m^3. EPA's April 27, 2018 memorandum, titled *Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program*, presents a 24-hour $PM_{2.5}$ Class I SIL of 0.27 µg/m^3. Is this value incorrect? If so, we will correct the value in Table 4-2 to 0.3 µg/m^3.

6. <u>Section 4.1.3.</u> *This section states that the OCD modeling will be performed using a full 360-degree arc of receptors placed at 50 km from RWF. The receptors will be separated by 1 degree resulting in an effective receptor spacing of approximately 870m. Based on Figure B-1, the receptor grid will include some land areas in the northern portion of the modeling domain. Terrain elevations for some of the receptors located on land will be substantially greater than the tops of the shortest RWF stacks*

that will be modeled. Therefore, to ensure that these higher terrain areas are captured in the modeling, EPA recommends that additional receptors be placed in the higher terrain areas with elevations that exceed the equivalent height of the shortest stack being modeled.

The construction modeling will instead use CALPUFF, which will have Class I receptors in Lye Brook Wilderness.

7. *Section 4.1.5. This section indicates that for 24-hour modeling, three unique scenarios are expected to occur. These scenarios will be modeled separately since they can be reasonably expected not to occur within the same 24-hour period. Based on our experience with other wind energy developers, it is our understanding that some of these activities would occur concurrently at different portions of the WDA. Please provide additional support or information to verify these scenarios are no expected to occur within the same 24-hour period.*

   The construction CALPUFF modeling will conservatively assume all of the emissions could occur concurrently.

8. *Section 4.3.2. This section states that transiting vessels will be modeled as 12-point sources stretching over the 25 nm (~40km) area from the lease area to the edge of the OCS Permit area. This equates to approximately one point source every 3.3km. While EPA appreciates the need to not overburden the model with point sources, we recommend that Tech Environmental consider simulating the transiting vessels with additional point sources, e.g., perhaps one point source very 1-2 km.*

   Tech will include transiting point sources every 1 km for O&M modeling using OCD, but construction modeling using CALPUFF will merge all of the emissions into a single source that will be conservatively located at the edge of the OCS Permit area nearest to Lye Brook Wilderness.

9. *Section 4.4. This section indicates that because the OCD model does not contain an algorithm to account for the formation of NO2 from NOX, the NO2 results may be adjusted using the EPA-provided ARM2 post- processor spreadsheet. The final modeling report should clearly document how the ARM2 mechanism was accounted for in post-processing.*

   The modeling report will detail how the ARM2 post-processing will be performed.

10. *Section 4.5. EPA is unable to duplicate the daily and annual NOx impacts shown in Table 4-8 based on annual NOx emissions of 2,725 tpy. We request clarification on how these values were determined.*

    The values presented in Table 4-8 will not be used for CALPUFF construction modeling. See response to Comment #12.

11. *Section 4.5. Using the search criterion described in the paragraph above Table 4-9 (maximum precursor impacts at distances greater than or equal to 50km for hypothetical sources in the northeast climate zone), we are unable to confirm the following values in Table 4-9:*

- *The CAMx impact for daily NOx impacts (.127 µg/m3 @ 500 tpy) listed in the Table. Using the Qlik application, we are showing a value of .414 µg/m3 @ 3,000 tpy.*
- *The CAMx impact for annual NOx impacts (.0071 µg/m3 @ 1,000 tpy) listed in the Table. Using the Qlik application, we are showing a value of .0119 µg/m3 @ 3,000 tpy.*
- *The CAMx emission rate for annual SO2 (1000 tpy). Using the Qlik Application, we are showing 3,000 tpy corresponding to an annual CAMx impact of .031 µg/m3; and*
- *The computed project impacts using the CAMx impacts and emission rates in the table.*

We request clarification on how these values were determined.

The values presented in Table 4-9 will not be used for CALPUFF construction modeling. See response to Comment #12.

12. Section 4.5. *EPA is unable to confirm the following values in Table 4-10:*
    - *The CAMx impact for daily NOx impacts (.0487 µg/m3 @ 1,000 tpy). Using the Qlik application, we are showing a value of .0914 µg/m3 @ 3000 tpy.*
    - *The CAMx impact for annual NOx impacts (.00155 µg/m3 @ 1,000 tpy). Using the Qlik application, we are showing a value of .0024 µg/m3 @ 3000 tpy; and*
    - *None of the computed project impacts with the exception of the computed project impact for Annual SO2.*

    We request clarification on how these values were determined.

    The NO_X values presented in Table 4-10 have been revised and represent the secondary emissions that will be used for the CALPUFF construction modeling. The below secondary impacts were estimated using 3,377 tpy of NO_X and 12.6 tpy of SO_2.

Table 4-10 Refined Second-Level Secondary $PM_{2.5}$ Impacts

	Daily $PM_{2.5}$				Annual $PM_{2.5}$			
Precursor	CAMx Impact (ug/m^3)	CAMx Emission Rate (tpy)	Project Impact (ug/m^3)	Total Impact (ug/m^3)	CAMx Impact (ug/m^3)	CAMx Emission Rate (tpy)	Project Impact (ug/m^3)	Total Impact (ug/m^3))
NO_X	0.0914	3,000	0.1029	0.1036	0.0024	3,000	0.002715	0.002739
SO_2	0.1738	3,000	0.0007		0.0057	3,000	0.000024	

13. Section 4.5. *The paragraph above Table 4-11 on page 22 of the modeling protocol states that EPA's MERPs guidance suggests using the maximum primary PM2.5 impact at a distance greater than, or equal to, the distance the Project is from the nearest Class I area, 252 km [136 nm] away. The following is an excerpt from page 52 of Section 4.1.2 of EPA's April 2019 MERPs Guidance:*

    "Another option for this screening step would also involve selecting the highest modeled secondary PM2.5 impact at or near the downwind distance of the Class I area relative to the project source but

include an estimate of primary PM2.5 impacts estimated with a chemical transport model (e.g., Lagrangian or photochemical model) at or less than the downwind distance of the Class I area relative to the project source."

Since the distance from the Project to the nearest Class I area is 252km, EPA recommends that a maximum distance of 200 km be used in the application of Table 4-2 of the MERPs Guidance.

If using CALPUFF for construction modeling, determining primary $PM_{2.5}$ impacts via MEPRs will be unnecessary.

O&M Emissions Modeling Protocol

14. *Sections 2.3.3.2. This section presents four reasons supporting non-inclusion of any on-land sources in NAAQS cumulative modeling. EPA's concurrence with exclusion from cumulative modeling of the sources located on Martha's Vineyard (Item 3) will, to a great extent, depend on the extent of the significant impact areas of the relevant pollutants for Revolution Wind, as well as the annual emissions of the sources proposed for exclusion.*

    Considering that EPA's memorandum "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard", cautions against applying nearby sources beyond 10 km, and the nearest reportable source is 18 km away, Tech took the approach that cumulative modeling of land-based sources would not be warranted. If one considers the extent of modeled impacts from other offshore wind projects, it can be reasonably expected that the extent of Revolution Wind impacts would not warrant modeling of land-based sources as has been the case for similar sized projects.

    The GenOn Power Canal LLC annual NO_X PTE is a little less than half of those expected from Revolution Wind's O&M phase. At 18 km away, it can be reasonably assumed that Revolution Wind's significant impact radius would have to extend out to at least 10 km to be reasonably considered as having the potential for cumulative impacts with GenOn Power Canal LLC.

15. *Section 2.3.3.2. This section also presents a case for not including South Fork Wind in a cumulative impact analysis for NAAQS modeling for Revolution Wind. After reviewing the relationship between Revolution Wind and South Fork Wind, EPA has preliminarily determined these two projects are the same stationary source for Clean Air Act permitting purposes.*

    EPA regulations define "stationary source" as "any building, structure, facility, or installation which emits or may emit a regulated NSR pollutant."[1] Those regulations, in turn, define the term "building, structure, facility, or installation" to mean "all of the pollutant-emitting activities which [1] belong to the same industrial grouping, [2] are located on one or more contiguous or adjacent properties, and [3] are under the control of the same person (or persons under common control)," with "same industrial grouping" referring to the same Major Group, two-digit SIC code.[2] EPA commonly refers to this three-part analysis as a "source determination" analysis.

The need for a cumulative impact analysis, within the context of EPA's Prevention of Significant Deterioration permitting program, may apply to the new Revolution Wind project. That is, if modeled impacts from Revolution Wind are above the SIL for any pollutant, a cumulative impact analysis that takes into account the pollutant emissions for South Fork Wind (and any nearby sources, if determined appropriate) would be required to be analyzed together, along with background concentrations. The protocol should be revised to account for the potential need for a cumulative impact analysis based on EPA's preliminary determination that the Revolution Wind and South Fork Wind projects are the same stationary source for Clean Air Act permitting purposes.

Tech proposes combining the SIL impacts presented in South Fork Wind's O&M Modeling Report with Revolution Wind's modeled SIL impacts and background concentrations and comparing those totals to the NAAQS. This method is conservative because it takes worst-case impacts for both projects and combines them without consideration for temporal or spatial alignment.

Pollutant	Averaging Period	NAAQS/ MAAQS	Selected Background Level	SFWF Impacts	Revolution Wind Cumulative Modeling Threshold
$PM_{2.5}$	24-hour	35	14.5	8.35	12.15
PM_{10}	24-hour	150	23.0	13.28	113.72

16. *<u>Section 2.3.4.1.</u> This section presents a case for not including South Fork Wind in cumulative 24-hour PM10 and PM25 increment modeling for Revolution Wind. Like our comment regarding NAAQS modeling, a cumulative impact analysis may be required for increment if Revolution Wind models above the SIL for any pollutant. See comment #15 for more details on EPA's rationale for requiring this.*

    As presented in the American Clean Power May 4, 2022 presentation, "Class II increments were intended to protect against prolonged exposure, which is not the case miles offshore". The only case of South Fork exceeding the SIL of a PSD Increment was for 24-hour $PM_{2.5}$ and PM_{10}, which was the result of modeling a repair activity that is only anticipated to occur for 14 days every two years. For a land-based facility, this type of activity likely would have never been modeled. If presented as a modification, the South Fork Wind Scenario 2 activity would have been well below the net emissions increase thresholds. A PSD Increment that is intended to protect against long-term exposure should not be applied to otherwise de minimis activity that occurs for 1.9% of any given year several kilometers from state waters and further be allowed to inaccurately consume 97% of an increment, as such a limited activity cannot reasonably be expected to cause a deterioration in air quality.

17. *<u>Section 2.3.4.1.</u> In this section, a case is presented for excluding South Fork Wind from any cumulative 24-hour PM10 and PM2.5 increment modeling. Modeling performed by South Fork Wind in support of their permit indicated that 97% of the 24-hour PM2.5 increment would be consumed. However, Tech Environmental argues that South Fork's modeling was overly conservative. Even though the modeling indicating near total consumption of the PM2.5 increment is likely conservative, the modeling does at least indicate a potential issue with the 24-hour PM2.5 increment in the area and*

this potential issue should be addressed. Since short term increments may only be exceeded once per year, and the 14 days of emissions associated with Scenario 2 could theoretically occur in one year, EPA recommends that South Fork be included in any cumulative PM2.5 increment modeling for Revolution. In the unlikely event that compliance with the increment cannot be demonstrated when modeling South Fork conservatively, then we further recommend that South Fork be modeled in a more realistic (less conservative) manner. An additional alternative would be to demonstrate that the 24-hour PM10 and PM2.5 significant impact areas for the two facilities do not overlap.

See Response to #16 above.

18. <u>Section 2.4.</u> *Section 2.4 indicates that based on preliminary emissions and distance to the nearest Class I location, it is not expected that impacts from the Project will have an adverse effect on visibility in the Class I area. Section 3.10 states that the results of the Q/D assessment will be summarized in the form "Request for Applicability of Class I Area Modeling Analysis" and provided to the U.S. Forest Service (USFS) for their determination on whether a Class I Air Quality Related Values (AQRV) analysis is needed. The USFS has requested an AQRV analysis for visibility impacts at Lye Brook from construction-related emissions.*

The Q/D assessment that was described in the O&M protocol was specific to O&M emissions. As detailed below, Tech disagrees that a Class I visibility assessment of Revolution Wind's construction phase emissions can be required, as 40 CFR 52.21(i) has explicit language that would exempt the project from such an analysis. Nevertheless, Revolution Wind has prepared a protocol for USFS to support their request despite not yet having the opportunity to demonstrate that the project is exempt.

Per 40 CFR 52.21(i),

> ***(3) The requirements of paragraphs (k), (m) and (o) of this section shall not apply to a major stationary source or major modification with respect to a particular pollutant, if the allowable emissions of that pollutant from the source, or the net emissions increase of that pollutant from the modification:***
> ***(i) Would impact no Class I area and no area where an applicable increment is known to be violated, and***
> ***(ii) Would be temporary.***

Because the project's construction phase is temporary and is not near any areas where an applicable increment is known to be violated, as EPA has previously found, the above exemption has always been on the table for Revolution Wind, as it has for previous offshore wind projects. If Revolution Wind demonstrates no impact to Class I areas during construction, then exemption from paragraph (o) applies, which would exempt the construction phase from performing a visibility analysis as explicitly stated in 40 CFR 52.21(o):

> ***(o) Additional impact analyses.***

> ***(1) The owner or operator shall provide an analysis of the impairment to visibility, soils and vegetation that would occur as a result of the source or modification and general commercial, residential, industrial and other growth associated with the source or modification. The owner or operator need not provide an analysis of the impact on vegetation having no significant commercial or recreational value.***
> ***(2) The owner or operator shall provide an analysis or the air quality impact project for the area as a result of general commercial, residential, industrial and other growth associated with the source or modification.***
> ***(3) Visibility monitoring. The Administrator may require monitoring of visibility in any Federal class I area near the proposed new stationary source for major modification for such purposes and by such means as the Administrator deems necessary and appropriate.***

At no point has any other project been required to demonstrate no visibility impacts at Class I areas to satisfy the criteria under 40 CFR 52.21(i)(3). In fact, when assessing whether previous projects have satisfied the criteria for the construction phase, EPA's Fact Sheets for Vineyard Wind and South Fork Wind make no mention of visibility impacts at Class I areas when making that determination.

19. *Section 2.6. Table 2-9 of this section indicates that a Class I SIL analysis is not necessary for O&M emissions. Per Table 2-1, PSD is triggered for NOx, PM10 and PM2.5. Since Class I increments are established for these pollutants, a Class I SIL analysis is required.*

    A 50 km ring of receptors with 1 degree spacing will be included in the O&M modeling to conservatively represent potential impacts at Class I areas. Furthermore, in response to EPA's comment #6, the 50 km receptor ring will include overland receptors every 100 km to ensure any complex terrain is captured.

20. *Section 3.4.1. This section of the protocol states that there are four scenarios that are expected to occur during the O&M phase of the Project. These scenarios include:*

    1) *routine daily inspections and maintenance,*
    2) *nonroutine repairs of WTGs and OSSs,*
    3) *routine infrequent array cable and foundation surveys and*
    4) *routine infrequent export cable surveys.*

    The protocol states that the use of survey vessels for Scenarios 3 and 4, will occur along the cable routes and will not meet the definition of an OCS source. Therefore, only Scenarios 1 and 2 will be included in the modeling. While EPA has found that the operating characteristics of a pull-ahead anchor cable laying vessel is not an OCS source, vessel emissions associated with servicing or associated with an OCS source/facility and occuring within 25 miles of the wind development area should be considered direct emissions of the source. We request you include in the modeling of impacts scenario 3 and 4 vessel emissions that occuring within 25 miles of WDA once the first OCS source is present on WDA.

The modeling will include Scenario 3. Scenario 4 is the same activity, located further from the OSS generators, so Scenario 3 has a higher potential for impacts and will be the Scenario modeled. The survey vessel is expected to survey 171 km of array cable within 26.7 days, equating to an average of 6.4 km per day. Therefore, the survey vessel emissions will be modeled as a point source located every 200 meters along the inter-array cables between the 5 WTGs nearest to shore, spanning 6,400 meters, for a total of 33 point sources.

21. <u>Section 3.4.2. & 3.4.3</u> *An example calculation should be provided for one of the vessels or pieces of equipment shown in Tables 3-4 and 3-6. These example calculations should be provided for each pollutant and averaging period and identify the key assumptions used in the calculation. We recommend that this calculation be shown for the vessel or equipment with the largest emissions for each Scenario.*

Example calculations will be included in the revised protocol. An example calculation for on-site (non-transit) short-term $PM_{2.5}$ emissions from the SOV auxiliary engine is below, which uses a Tier 4 emission factor, BOEM default engine ratings and a BOEM default load factor. This is the only O&M vessel emission calculation that uses a Tier 4 emission factor. The CTVs use an IMO Tier II emission factor for NO_X. All other O&M vessels use a BOEM default emission factor.

$$0.310\,\frac{g}{kWhr}\ x\ 201\ kW\ x\ 1.0\ x\ \frac{1\ hr}{3600\ s} = 0.0173\ g/s$$

For dynamic positioning vessels (all except CTVs, SOV daughter and jack-up), the main/propulsion engines are also calculated for on-site emissions and combined with the auxiliary engine emissions when determining on-site modeling emission rates. Below is an example of the short-term $PM_{2.5}$ emissions from the SOV main/propulsion engines, which uses a Tier 4 emission factor, vessel-specific engine ratings and a BOEM default load factor.

$$0.250\,\frac{g}{kWhr}\ x\ 6920\ kW\ x\ 0.2\ x\ \frac{1\ hr}{3600\ s} = 0.0961\ g/s$$

For 1-hour NO_X and long-term emissions calculations, the emission factors are also multiplied by the hours that each vessel is expected to be on-site and divided by 8,760 hours. Below are tables that provide the source of emission factors and engine ratings used in the emission calculations for each vessel.

Marine Vessel Main Engine Emission Factors (g/kW-hr)						
Vessel Type	**Applied to**	**CO**	**NOX**	**PM10**	**PM2.5**	**SO2**
Crew	SOV daughter	2.30	9.15	0.310	0.300	0.006
Jackup	Jack-up	2.30	10.03	0.308	0.298	0.013
Research/Survey	Survey	2.25	9.86	0.339	0.326	0.066
Crew / NOS Developer	CTVs	2.30	**7.80**	0.310	0.300	0.006
Crew / ECO Edison	SOV	2.30	**1.80**	**0.250**	**0.250**	0.006

Marine Vessel Auxiliary Engine Emission Factors (g/kW-hr)						
Vessel Type	**Applied to**	**CO**	**NOX**	**PM10**	**PM2.5**	**SO2**
Crew	SOV daughter	2.48	10.37	0.320	0.310	0.006
Jackup	Jack-up	2.48	11.55	0.320	0.310	0.006
Research/Survey	Survey	2.48	10.21	0.320	0.310	0.006
Crew / NOS Developer	CTVs	2.48	10.37	0.320	0.310	0.006
Crew / ECO Edison	SOV	2.48	**1.80**	**0.250**	**0.250**	0.006

Legend
IMO Tier II
EPA Tier 4
BOEM default

Marine Vessel Engine Defaults			
StandardType	**Applied to**	**Main kW**	**Aux kW**
Crew	SOV daughter	3013	201
Jackup	None	3215	895
Research/Survey	None	2997	1363
Crew / NOS Developer	CTVs	**2204**	201
Crew / ECO Edison	SOV	**6920**	201
Jackup / Pacific Orca	Jack-up	**22400**	895
Research/Survey / Helix Grand Canyon III	Survey	**16637**	1363

Legend
Vessel Specific - more than default
Vessel Specific - less than default
BOEM default

22. *Section 3.4.4. This section states that transiting vessels will be modeled as 12 point sources stretching over the 25 nm (~40km) area from the lease area to the edge of the OCS Permit area. This equates to approximately one point source every 3.3km. While we appreciate the need to not overburden the model with point sources, we recommend that Tech Environmental consider simulating the transiting vessels with additional point sources, e.g., perhaps one point source very 1-2 km.*

    The transit emissions modeling will be represented by point sources located every 1 km.

23. *Section 3.5. Because the OCD model does not contain an algorithm to account for the formation of NO2 from NOX, the NO2 results may be adjusted using ARM2 post-processing. The final modeling report should clearly document how the ARM2 mechanism was applied in post-processing.*

The modeling report will detail how the ARM2 post-processing will be performed.

24. *Section 3.6. Clarification is requested regarding the locations that will be used for the sources included in the long-term modeling.*

    Please see the attached figure depicting the source locations that are proposed for the long-term modeling.

25. *Section 3.9. This section of the protocol presents justification for use of intermittent treatment of O&M activities for modeling 1-hour NO2. Using this approach, for each WTG or OSS location, the O&M vessels will be modeled based on the number of hours per year they will be emitting at that location, divided by 8,760. On page 25 of Section 3.9, it is stated that for each WTG or OSS location, the O&M vessels were modeled based on the number of hours per year they would be emitting at that location, divided by 8,760. We would like confirmation that this annualization of emissions and associated modeled emission rates in Tables 3-4 and 3-6 were calculated in this manner.*

    There is a typo in the NO_X emission rate for the CTV that is presented in Table 3-4. The annualized NO_X emission rate for the Non-routine WTG and OSS Repair would be 0.014 grams per second instead of 0.2 grams per second. The NO_X emission rates presented in these tables are the total annualized emission rates from the source, rather than the emission rate that will be modeled at each location of activity.

Meteorological Data Evaluation

1. *The EPA requests that Appendix A be modified to define the mathematical formulas that are used to compute values of mean bias and fractional bias discussed in the Appendix. Mean and fractional bias are used in Appendix A to evaluate the performance of WRF/MMIF at predicting certain meteorological variables. These statistics are also used to compare air pollutant concentrations predicted by AERMOD using WRF/MMIF meteorological data to pollutant concentrations predicted by AERMOD using observed meteorological data. There are several instances in Section A.2.4 and in Section A.3 in which negative bias is described as under-prediction by WRF and positive bias is described as over-prediction by WRF. Confirmation is requested that the descriptions of over- or under-prediction by WRF are consistent with the formula used to compute fractional and mean bias.*

    A revised Appendix A is attached and includes defined mathematical formulas that are used to compute values of mean bias and fractional bias. These formulas are provided below. Some inconsistencies were identified in the calculations of Fractional Bias for the WRF/MMIF AERMOD modeling results and have been corrected. Throughout the evaluation, positive bias indicates overprediction by the WRF and negative bias indicates underprediction by the WRF. The meteorological data evaluation is being moved to the O&M protocol since the construction modeling will be using CALPUFF.

$$Mean\ Bias = \frac{1}{n}\sum_{1}^{n}(WRF - Observed)$$

$$Fractional\ Bias = \frac{2}{n}\sum_{i=1}^{n}\frac{(WRF_i - Observed_i)}{(WRF_i + Observed_i)}$$

2. *<u>Section A.2.4.</u> The EPA recommends that the statistics comparing WRF data to observed data for KMVY, as shown in Tables A-2 through A-8, also be developed for the observed meteorological parameters for BUZM3. Based on the National Data Buoy Center website, the following meteorological parameters are collected at BUZM3: air temperature, atmospheric pressure, and wind speed.*

   The revised Appendix A contains this information in Tables A-9 through A-15.

3. *<u>Section A.2.4.</u> In Tables A-6 through A-8, the values of R2 are less than -1 for Heat Flux. EPA requests an explanation for these values.*

   An error was identified, causing this issue, which has been corrected and the values are now within the expected range of 0 to 1.

4. *<u>Section A.2.4.</u> In Tables A-2, A-3, A-4, A-6 and A-8, value of R2 for the Monin-Obukhov Length are less than -1. EPA requests an explanation for these values.*

   See response to above Comment #3.

5. *<u>Section A.2.4.</u> Since water surface temperature is a required overwater input to the OCD model, EPA recommends that water temperature data from the Block Island buoy (buoy 44097) be compared to the water temperature in the extracted WRF data for the Revolution Wind centroid.*

   The revised Appendix A contains this information in Table A-16.

6. *<u>Section A.3.</u> Even though several months of 2019 data were missing from the Buzzards Bay buoy, EPA recommends that available 2019 data be used in the comparative dispersion modeling analysis.*

   The dispersion analysis was updated to include the 2019 Buzzards Bay buoy data that was available. Figures A-12 through A-16 now represent the comparative dispersion modeling using all available 2018 through 2020 data.

7. *<u>Section A.3.</u> EPA recommends that a figure be included in Section A.3 to depict the locations of the single point sources modeled and the receptor grids used.*

Figures A-17 and A-18 in revised Appendix A depict the source and receptor locations used for the overland and overwater meteorological comparison modeling.

8. <u>Section A.3.1.</u> *Explanation is requested regarding the statistical relationship between Figure A-7 and Figure A-9 and Figure A-8 and A-10.*

   Explanations of the relationships between the revised figures have been incorporated in the revised Appendix A.

9. <u>Section A.3.2.</u> *Figure A-13 depicts positive values of bias of the average greater than 2 for modeling for the 1-hour averaging period. Further discussion in the comparison of this issue is requested.*

   An error was identified causing the bias to appear larger than it is. The error has been corrected in Figure A-13.

10. <u>Section A.3.2.</u> *Explanation is requested regarding the statistical relationship between Figure A-13 and Figure A-15 and Figure A-14 and A-16.*

    Explanations of the relationships between the revised figures have been incorporated in the revised Appendix A.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

SENT VIA ELECTRONIC MAIL

August 1, 2022

Whitney Marsh, Environmental Manager
NA Permitting
Ørsted
56, Exchange Terrace, Suite 300
Providence, Rhode Island 02903

Re: EPA Review of Air Quality Impact Modeling Protocol for Revolution Wind, LLC

Dear Ms. Marsh:

On July 9, 2022, EPA received the CALPUFF construction modeling protocol for the Revolution Wind project. EPA has reviewed the information submitted by RW and is providing comments based on our review. EPA's comments are included as an enclosure to this letter. Please note that comments from the U.S. Forest Service are not included in the enclosure and will be provided separately.

Thank you for the opportunity to review the CALPUFF construction modeling protocol. We understand an evaluation of prognostic meteorological for use with CALPUFF will be provided under a separate cover.

If you have any questions, please contact Chris Howard at (404) 562-9036 or howard.chris@epa.gov.

Sincerely,

Patrick Bird, Manager
Air Permits, Toxics, and Indoor Programs Branch

Enclosure

Cc: Katherine Mears, Tech Environmental
Marc Wallace, Tech Environmental

ENCLOSURE

EPA Review of July 9, 2022, Revolution Wind Farm (RWF) Response to draft of Air Quality Impact Modeling Protocol – Construction Impact on Class I SIL

Section 4.1 – Model Section

- The current regulatory versions of CALPUFF and CALPOST should be used in the modeling. The current EPA-approved version of CALPUFF is 5.8.5 level 151214. The current EPA-approved version of CALPOST is 6.221 Level 080724.

Section 4.4.1 – RWF Construction Vessels, Vessel Equipment/Generators and WTG Cable-Pulling Vessel

- This Section indicates that the emissions from on-site RWF vessels (all non-export cable vessels in Table 3-1), the WTG cable pulling generator (Table 3-2) and vessel equipment (monopile and turbine installation equipment in Table 3-3) will be modeled in CALPUFF using a single merged point source. For long-term modeling, the point source will be located at the centroid. For short-term modeling, the point source will be located at the WTG nearest to Lye Brook Wilderness. EPA requests justification for placing the point sources at the WTG nearest Lye Brook for short-term modeling and at the project centroid for long-term modeling.

Section 4.6 – CALPUFF Configuration

- This section indicates that NO_X to NO_2 conversion will be calculated using CALPOST with a table of conversion rates which vary by NO_X concentration. The binned conversion rates will be set consistent with the values used in the AERMOD ARM2 method. Based on conversations with Katherine Mears of Tech Environmental, it is our understanding that the ARM2 conversion rates will not be used. This section of the protocol should be revised to reflect that.

Section 4.8 – Model Domain

- EPA recommends that a figure be added to show the CALPUFF modeling domain including the locations of the Revolution Wind Farm and the Lye Brook Wilderness area receptors.

Ørsted | EVERSOURCE

MEMORANDUM

To: Patrick Bird, Manager, EPA Region 1 – Air Permits, Toxics, and Indoor Programs Branch
From: Whitney Marsh, Ørsted
CC: Marc Wallace & Katherine Mears, Tech Environmental
Date: August 12, 2022
Subject: Revolution Wind OCS Air Permit Application- Construction Class I SIL and Visbility Modeling Protocol Response to Comments

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Tech Environmental, Inc. (Tech) is responding to EPA's comment letter, dated August 1, 2022. In response to your comments, Tech has revised Revolution Wind's Air Quality Impact Modeling Protocol – Construction Class I SIL and Visibility. Tech has provided responses below to address each of your received comments.

1. *Section 4.1. The current regulatory versions of CALPUFF and CALPOST should be used in the modeling. The current EPA-approved version of CALPUFF is 5.8.5 level 151214. The current EPA-approved version of CALPOST is 6.221 Level 080724.*

   These will be the CALPUFF and CALPOST versions used, and the protocol has been revised to clarify.

2. *Section 4.4.1. This Section indicates that the emissions from on-site RWF vessels (all non-export cable vessels in Table 3-1), the WTG cable pulling generator (Table 3-2) and vessel equipment (monopile and turbine installation equipment in Table 3-3) will be modeled in CALPUFF using a single merged point source. For long-term modeling, the point source will be located at the centroid. For short-term modeling, the point source will be located at the WTG nearest to Lye Brook Wilderness. EPA requests justification for placing the point sources at the WTG nearest Lye Brook for short-term modeling and at the project centroid for long-term modeling.*

   As discussed during our August 4, 2022 virtual meeting with EPA, Section 4.4.1 of the protocol has been revised to justify this approach for the long-term modeling.

3. *Section 4.6. This section indicates that NOX to NO2 conversion will be calculated using CALPOST with a table of conversion rates which vary by NOX concentration. The binned conversion rates will be set consistent with the values used in the AERMOD ARM2 method. Based on conversations with Katherine Mears of Tech Environmental, it is our understanding that the ARM2 conversion rates will not be used. This section of the protocol should be revised to reflect that.*

   The protocol has been revised to reflect that we do not intend on using the ARM2 method for NOX to NO2 conversion, and will instead conservatively assume 100% conversion.

4. *<u>Section 4.8.</u> EPA recommends that a figure be added to show the CALPUFF modeling domain including the locations of the Revolution Wind Farm and the Lye Brook Wilderness area receptors.*

   Figure A-3 has been revised to include the boundary of the CALPUFF model domain which matches that of the MMIF domain used to produce the WRF meteorological data outputs provided by EPA.